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[THIRD SERIES.]

Art. I.—*Results derived from an examination of the United States Weather Maps for* 1872, '73, *and* '74; by Elias Loomis, Professor of Natural Philosophy in Yale College. Third paper. With Plate I.

[Read before the National Academy of Sciences, Washington, April 20, 1875.]

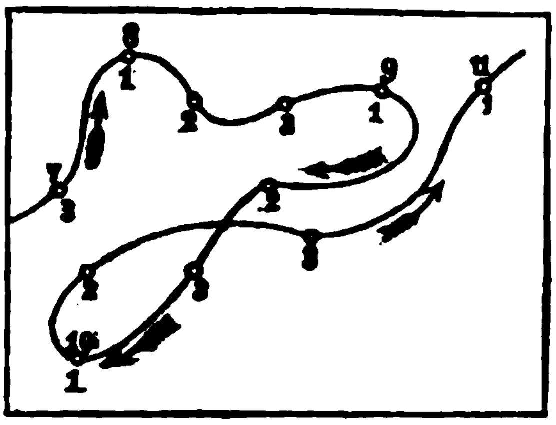
In this Journal for July, 1874, I gave the average direction of storm paths and the velocity of progress for each month of the year as deduced from 314 cases in 1872 and '73. I have made a similar examination of the weather maps for 1874, and now present the results derived from 171 cases for that year, together with the average results derived from combining all the observations of the three years, making in the aggregate 485 cases.

	Results for 1872 & 73.		Results for 1874.		Results for 3 years.	
	Course of storm.	Velocity in miles per hour.	Course.	Velocity.	Course.	Velocity.
January	N. 85° E.	28·5	N. 74° E.	23·0	N. 81° E.	26·7
February	76	31·0	70	33·9	74	32·0
March	79	30·8	86	29·8	81	30·5
April	74	25·6	68	31·4	72	27·5
May	78	24·2	76	22·2	77	23·5
June	93	21·2	81	22·4	89	21·6
July	102	24·4	88	25·9	97	24·9
August	85	17·7	85	19·9	85	18·4
September	78	22·8	70	23·1	75	22·9
October	69	24·4	84	28·5	74	25·8
November	80	28·3	74	30·3	78	29·0
December	84	27·6	81	32·7	83	29·3
Year,	N. 82° E.	25·6	N. 78° E.	26·9	N. 81° E.	26·0

The average course of the storms in 1874 was four degrees more northerly than for the two preceding years, and the average velocity was 1·3 miles per hour greater; but the change both in the direction and velocity depending upon the season of the year was similar to that before noticed. According to the combined results derived from the three years observations, the course of storms is most southerly in July, and most northerly in April and October, the mean difference between the extreme months amounting to 25°. The velocity of progress is greatest in February, and least in August, the former exceeding the latter by 74 per cent. In only one instance was the course of a storm for an entire day directed toward a point west of north. This occurred on the 18th of April, in the case of a storm which originated in the Gulf of Mexico, and whose course for one day was 13° west of north. The most southerly direction for the year occurred in the case of the storm of Aug. 21st, whose course for one day was N. 163° E., or S. 17° E., a directional most exactly opposite to that of the storm of April 18th.

The most rapid progress of a storm center observed in one day occurred Feb. 22nd, being 1280 miles, or 53·3 miles per hour; and the least velocity occurred Aug. 21st, being 228 miles in 24 hours, or 9·5 miles per hour.

These are the results derived from observations made at intervals of 24 hours. If we make the comparison at intervals of eight hours, we shall find much greater variations in respect to both direction and velocity. According to the monthly maps, published under the direction of the Chief Signal Officer, from the 7th to the 11th of May, 1874, the path of a storm center situated about 300 miles west of Lake Superior was such as is represented by the annexed diagram; where the figures above the curve line show the days of the month, and those below 1, 2, 3, indicate respectively the 7.35 A. M., 4.35 P. M. and 11 P. M. observations. It will be perceived that the direction of the storm's progress changed more than 180° in 24 hours, and on the morning of the 11th the center of the storm was distant less than 100 miles from its position on the morning of the 9th. If, then, we regard the actual motion of the storm's center from hour to hour, as remarked in my former article, we find that the storm path may have any direction whatever, and the velocity of progress may vary from 15 miles per hour toward the west, to 60 miles per hour toward the east.



Diurnal inequality in the progress of storms.

In order to ascertain whether the progress of storms is uniform throughout the entire day, I availed myself of the monthly maps issued by the Signal Service Bureau. These maps show the position of the storm centers for three hours of the day, viz: at 7.35 A. M., which is designated by (1); at 4.35 P. M., which is designated by (2); and at 11 P. M., which is designated by (3). On each storm track, the distance from 1 to 2, from 2 to 3. and from 3 to 1 (of the next day), was carefully measured on a scale of inches, and these distances were afterward reduced to miles by computation. The total distance traveled by a storm center during each interval was divided by the number of hours in the interval, and thus the hourly velocity of progress obtained for three different portions of the day. The following table shows the average results of this comparison for the storm paths for 1873 and 1874. The numbers given in column second represent the average hourly velocity in miles for the interval from 7.35 A. M. to 4.35 P. M.; the numbers in column third for the interval from 4.35 P. M. to 11 P. M.; and the numbers in column fourth represent the velocity from 11 P. M. to 7.35 A. M. of the following day.

	1–2	2–3	3–1		1–2	2–3	3–1
Jan.	26·6	37·3	28·2	July	26·2	32·6	26·2
Feb.	28·6	37·0	28·9	Aug.	24·2	28·6	20·8
March	27·2	33·6	27·2	Sept.	23·9	30·2	24·5
April	22·5	26·9	22·9	Oct.	22·9	29·8	23·5
May	19·2	25·6	19·5	Nov.	33·6	40·6	29·3
June	22·5	25·9	22·2	Dec.	33·3	37·0	29·9
				Year,	25·9	31·9	25·4

From this table it appears that the average velocity of storms from 4.35 P. M. to 11 P. M. is about 25 per cent greater than it is for the remainder of the day. This excess varies for the different months, ranging from 14 to 32 per cent, but in each month the most rapid progress occurs during the same portion of the day.

This diurnal inequality is doubtless connected with a diurnal inequality in some one and perhaps several of the other meteorological elements. Its maximum value apparently occurs about 7 P. M. Now this is not the hour of the maximum force of the wind, nor of the maximum or minimum temperature, and hence it may be presumed that the inequality does not depend directly upon the velocity of the wind nor upon the absolute temperature. This hour (7 P. M.) is, however, the time when the temperature of the day is declining most rapidly,

and this condition must be favorable to a rapid extension of the rain-area in front of a storm. When, at a given place in front of a storm center, a system of causes is in operation which is soon to result in a fall of rain, the ordinary change of temperature at evening must accelerate the commencement of the rainfall; that is, must extend the rain-area more rapidly, and this, we have seen in a former article (this Jour., vol. viii, p. 3), must increase the velocity of the storm's progress.

This extension of the rain-area in front of a storm does not perhaps necessarily imply an increase in the average rainfall for that part of the day; nevertheless, I have endeavored to determine whether there is a diurnal inequality in the fall of rain. For this purpose I first examined the observations made at Girard College, Philadelphia, from 1840 to 1845, but found only seven months (viz: Jan., March, June, July, Aug., Sept., Oct., 1843) in which the self-registering rain-gauge is reported to have been in good condition. In the following table, column second shows the aggregate amount of rain at Philadelphia for each hour of the day during these seven months.

Rainfall at Philadelphia.

Hour.	Rain, Inches.	Average.	Hour.	Rain, Inches.	Average.
Midnight	1·633	0·869	Noon	0·366	0·914
1 A.M.	0·748	·917	1 P.M.	·783	·861
2	·398	·826	2	1·438	1·036
3	·666	·636	3	0·869	1·152
4	·686	·677	4	1·727	1·265
5	·684	·731	5	0·945	1·234
6	·949	·716	6	1·346	1·580
7	·671	·733	7	1·285	1·310
8	·588	·822	8	2·598	1·206
9	·771	·802	9	0·375	1·165
10	1·133	·741	10	·427	1·235
11	0·848	·780	11	1·140	0·865

As these numbers show considerable irregularities, I have taken the average of each successive five numbers in column second and set down the results in column third. These resulting numbers show a pretty steady progress from a minimum at 3 A. M. to a maximum about 6 P. M., and from thence a steady decline to the following minimum. The maximum is nearly 2½ times the minimum, although the former is made too small and the latter too great by the mode of reduction employed. It seems probable, therefore, that the diurnal inequality in the rainfall, as indicated by these observations, is a law of the Philadelphia climate, and we may presume, therefore, that it is a law for the immediate vicinity of Philadelphia.

I next examined the observations made at the signal service

for Sept., Oct., and Nov., 1872, these being the only for which the observations have been fully published, nfined the comparison to those stations which are north i5°. The total rainfall for a month at all the stations the parallel of 35° was determined for each of the tervals into which the day is divided; these results were by the number of days in the month, giving the aver- y fall for each of these intervals; and these last results ided by the number of hours in the corresponding inter- ng thus the average hourly rainfall for all the stations : three portions of the day. The following is the final

Hourly rainfall at the S. S. Stations.

	1—2	2—3	3—1
ptember	0·244 inch	0.308 inch	0·288 inch
tober	·174	·200	·192
›vember	·155	·143	·180
:an	0·191	0·217	0·220

numbers indicate that the average rainfall for the sta- 1ployed is nearly uniform throughout the day. If, ere is a decided diurnal inequality in the rainfall at phia, it seems probable that for other parts of the the maximum takes place at a different hour, so that g the aggregate for a series of stations stretching across inent, the total rainfall is nearly uniform for all hours ay.

british Government has published the hourly observa- rainfall for eleven months of the year 1874 at seven viz: two in Ireland, two in Scotland, and three in . From these observations it may be inferred that not : absolute amount of rain, but also the time of maxi- epends very much upon the locality. In the aggregate even stations there are indications of two daily max- at 5 in the morning, and the other at 7 in the evening, 1ima near noon and midnight; but since the fall of rain dent upon such a variety of causes, it is hazardous to eneral conclusions, except from a long series of ob- 1s.

Influence of rainfall upon the course of storms.

ormer paper (this Jour., vol. viii, p. 4) I endeavored to e connexion between the velocity of a storm's progress extent of the rain-area on the eastern side of the storm. 1ade a similar comparison of the observations of 1874, present the results. The number of cases suited to

this comparison in 1874 was 80; and I have divided them into four equal classes, the first division embracing those cases in which the progress of the storm in one day was at least 855 miles; the second, those cases in which the progress was from 855 to 665 miles; the third, from 665 to 490; and the fourth embracing the cases in which the progress was less than 490 miles in one day. In the following table, columns one and two show the results heretofore published, derived from the observations of 1872 and '73; columns three and four show the results derived from the observations of 1874, while columns five and six show the results derived from combining the observations of the three years.

Obs. of 1872 and 73.		Obs. of 1874.		3 years obs.	
Velocity in miles per hour.	Extent of rain-area in miles.	Velocity.	Rain-area.	Velocity.	Rain-area.
38·8	590	42·7	740	40·1	640
28·5	548	30·7	609	29·2	568
21·6	503	23·7	611	22·3	539
14·5	365	17·0	535	15·3	422

Although the velocity of progress does not appear to be strictly proportioned to the eastward extent of the rain-area (for the observations are seldom sufficiently numerous to indicate precisely the extent of this area, and it is plain that there are other causes which contribute to influence the result), yet I think it is well established that an unusual extension of the rain-area is generally accompanied by a velocity of progress greater than the mean. The result of the three years' observations shows the average extent of the rain-area eastward from the center of the storm to be 542 miles. When the eastern extent of the rain-area is 100 miles greater than the mean, the hourly velocity of the storm's progress is increased 13·7 miles: but when the eastern extent of the rain-area is 100 miles less than the mean, the hourly velocity of the storm's progress is diminished 9·5 miles.

I have also determined the influence of the rain-area upon the direction of the storm's path, as shown by the observations of 1874, in the same manner as described in my former paper (this Jour., vol. viii, p. 5). The following table shows: first, the results heretofore published; second, the results derived from the observations of 1874; and third, the results derived from combining the observations of the three years.

Obs. of 1872 and '73.		Obs. of 1874.		Obs. of three years.	
Course of Storm.	Axis of Rain-area.	Course of Storm.	Axis of Rain-area.	Course of Storm.	Axis of Rain-area.
N. 40° E.	N. 53° E.	N. 53° E.	N. 54° E.	N. 44° E.	N. 53° E.
N. 116 E.	N. 118 E.	N. 100 E.	N. 109 E.	N. 111 E.	N. 115 E.

From the result of three years' observations, it appears that hen the course of a storm is most northerly, the axis of the in-area is inclined to the storm's path 9° toward the south; at when the course of a storm is most southerly, the axis of le rain-area is inclined to the storm's path only 4°. If, then, i any case we can learn the precise limits of the rain-area bout a storm-center, we ought to be able to predict with con- derable confidence the direction and velocity of the storm's rogress.

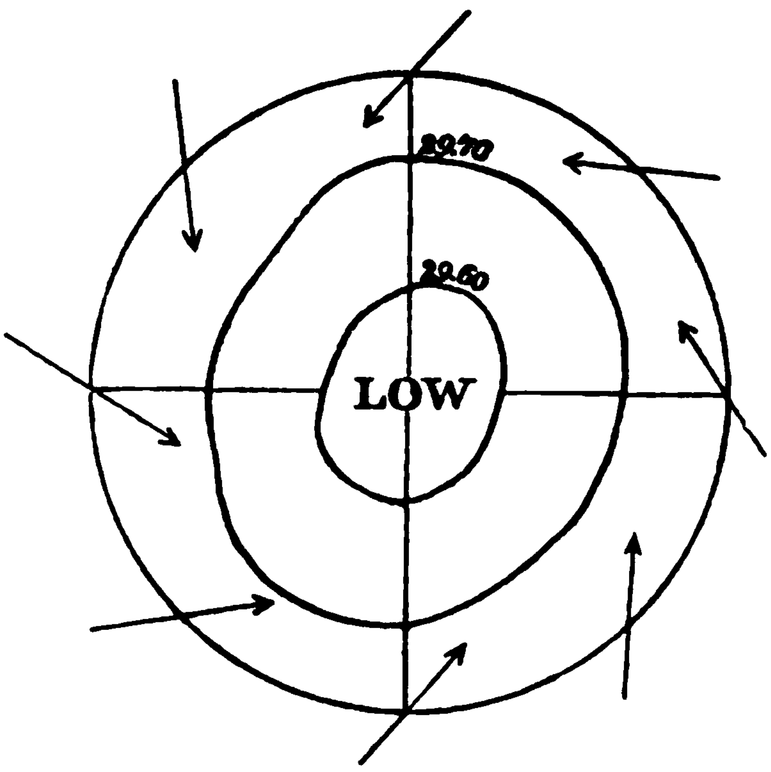
nfluence of a neighboring area of high barometer upon the progress of a storm.

In order to determine the influence of a neighboring area of igh barometer upon the progress of a storm, I selected all iose cases in which a weather map showed both a storm cen- r and an area of high barometer. I then divided the cases ito eight classes, according to the direction of the center of igh barometer from the center of low barometer. From the nter of low barometer I drew eight radii, making with each her angles of 45°, and so situated that two of the octants iould be bisected by a meridian line. These octants are desig- ited by the terms, north, northeast, east, etc. A large sheet f paper was then ruled with appropriate divisions for each of ie octants, and when the area of high barometer was on the rth side of the storm center, the velocity and direction of the orm's path were entered in the column headed north. I pro- eded in like manner with each of the cases in succession. n average was then taken of the directions and velocities in e several columns.

The following table shows the result of this comparison for 372, '73 and '74. Column 1st shows the direction of the area high barometer from the storm center; column 2d shows e number of cases employed; column 3d shows the average locity of the storm's progress; and column 4th shows the rection in which the storm advanced.

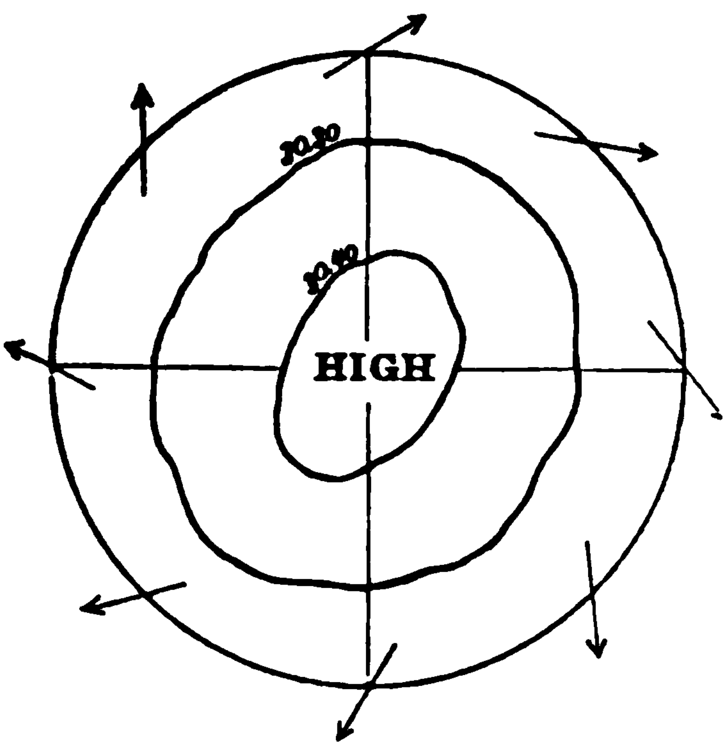
Direction of high barometer.	No. of Cases.	Velocity of Storm.	Direction of Storm-path.
North	23	26·0	N. 58° E.
N.E.	39	26·4	54
East	90	25·4	83
S.E.	75	29·5	90
South	25	30·3	93
S.W.	20	26·1	81
West	37	28·8	70
N.W.	19	28·7	62

The influence of a neighboring area of high barometer upon the velocity of a storm's progress is not very decided, nevertheless the observations indicate that when the high barometer is on the east side of the storm, the velocity of the storm's progress is diminished eight per cent; and that the velocity is increased by about the same amount when a high barometer is situated on the south side of the storm.



The effect of an area of high barometer upon the direction of a storm's progress seems to be more decided, the course of the storm being most northerly when the high barometer is on the northeast side, and most southerly when the high barometer is on the south or southeast side; in each case the storm-path is deflected toward the center of high barometer.

By referring to my former article (this Journal, vol. ix, p. 2) it will be seen that on whichever side of a storm center an area of high barometer is situated, both systems tend to impress nearly the same direction upon the intermediate air. It seems, therefore, that the immediate effect of an area of high barometer must be to extend the area of the wind which belongs to that side of the storm, and probably also to increase the velocity of the wind upon that side of the storm which is toward the high barometer. If, then, the high barometer is on the southeast side of the storm's center, the south wind which



belongs to that side of the storm should extend to a greater distance, and probably blow with increased force, which would cause increased rainfall upon that side, and the storm's path would incline in that direction. In like manner, if the high barometer were on the north side of the storm's center, the increased precipitation on that side should cause the storm's path to incline more to the northward.

It might be supposed that the same course of reasoning would lead us to conclude that a storm's progress should be most rapid when there is an area of high barometer on its eastern side. To this it may be answered, that although the fall of the barometer in such a case should be more rapid than usual, still, as the barometer starts from a point unusually high, the fall must continue for a proportionally longer time before the minimum is reached. The same consideration may in part explain why the progress of a storm is not as much accelerated by a high barometer on the northeast side as it is by a high barometer on the southeast side. In the former case, the high barometer is nearer to the track which the storm is to pursue, and there must be a greater fall of the barometer before the minimum is attained.

Form of the isobaric curves.

In my first article (this Jour., vol. viii, p. 11) I gave some comparisons illustrating the form of the isobaric curves about a storm center, as shown by the weather maps of 1872 and '73. I have made a similar comparison for the storms of 1874, and with the following results: The number of cases found suited to this kind of comparison was 75. In 35 of these cases (that is, 47 per cent of the whole) the major axis of the isobar measured was at least double the minor axis. In 15 cases (that is, 20 per cent of the whole) the major axis was at least three times the minor axis; and in 5 cases (that is, 7 per cent of the whole) the major axis was at least four times the minor axis. The average form of the isobars about a storm center may be said to be an irregular oval, whose length is nearly double its breadth. In order to give a more distinct idea of the form of these curves, I have selected the storm of March 29, 1873, and have represented several of the isobars on the accompanying chart, Plate I. It will be seen that the longer diameter of these curves is nearly three times the shorter diameter. The arrows show the direction of the wind at the signal service stations, and the force of the wind is partially indicated by the length of the arrows; a length of 0·4 inch indicating a velocity of at least 20 miles per hour; a length of 0·3 inch a velocity of from 10 to 20 miles; and a length of 0·2 inch a velocity less than 10 miles per hour.

An inspection of this map will show that the centrifugal force arising from the circulation of the wind around the storm center cannot be the principal cause for the fall of the barometer, for otherwise the form of the isobars would be more nearly circular.

With regard to the direction of the major axis of the isobars, there is but little tendency to uniformity; nevertheless, the most prevalent direction is about N. 35° E., which is almost identical with the result derived from the observations of 1872 and '73.

Great and sudden changes of temperature.

In a former paper (this Jour., vol. ix, p. 8) I called attention to the great and sudden changes of temperature frequently experienced in the United States and in other parts of the world, and suggested an explanation of this phenomenon. I will now present some additional facts bearing upon the same question. In the Report of the Chief Signal Officer for 1873 is given the maximum and minimum temperature of each day in 1873 at 40 stations in the United States and Canada. I have examined these tables to find all the cases in which the difference between the maximum and minimum of the same day amounted to at least 40°. The following table shows all the stations at which so great a difference was observed, and also the number of cases which occurred each month.

Diurnal Change of Temperature of 40° and upwards in 1873.

	Lat.		Lon.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	′	°	′													
Denver	39	44	104	58	3	5	5	2	2	6	4	3	4	*	1	2	37
Fort Sully	44	39	100	40	3	..	2	4	..	1	..	1	5	[illegible]	..	1	26
Cheyenne	41	12	104	42	1	1	..	1	..	4	3	..	2	3	3	2	20
Virginia City	45	0	112	3	2	..	*	*	*	2	1	*	*	1	2	[illegible]	11
Breckenridge	46	16	96	38	1	..	..	..	..	1	1	..	..	6	..	..	8
Fort Garry	49	52	96	58	..	..	..	..	4	..	3	..	1	*	*	..	8
San Antonio	29	25	98	25	..	..	..	6	2	..	..	..	..	..	..	..	8
La Crosse	43	48	91	27	3	2	1	..	..	..	..	..	..	1	..	..	7
Halifax	44	40	63	35	..	1	..	..	1	..	..	1	1	*	*	*	4
Geneva	42	53	77	5	..	..	..	..	..	2	*	*	1	*	..	..	3
Omaha	41	16	96	0	..	..	1	..	1	..	..	..	..	*	*	*	2
Chicago	41	52	87	38	..	1	..	..	1	..	..	..	..	..	..	..	2
Leavenworth	39	19	94	58	..	..	..	1	..	..	..	..	..	..	..	..	1
St. Paul	44	53	93	5	..	..	1	..	..	..	..	..	..	..	..	..	[illegible]
Morgantown	39	40	79	55	*	..	1	..	..	..	..	..	..	*	*	*	1
Oswego	42	28	76	35	1	..	..	..	..	..	..	..	..	*	*	..	1

An asterisk shows that observations for the month indicated are wanting.

The number of stations at which a difference of 40° between the maximum and minimum of the same day was observed in

373, is 16, which is 40 per cent of the whole number of sta-
ons; and among the stations at which so great a difference
as *not* observed, are Kingston, Toronto and Montreal, in
anada, and the summit of Mount Washington in New Hamp-
ire.

In the Report of the Chief Signal Officer for 1874 is given
e maximum and minimum temperature of each day in 1874
. 107 stations in the United States and Canada. The follow-
g table shows all the cases in which the difference between
e maximum and minimum of the same day amounted to at
ast 40°.

***Diurnal Change of Temperature of* 40° *and upwards in* 1874.**

	Lat.		Lon.		Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
	°	′	°	′													
Colorado Springs	38	55	104	58	8	3	4	3	11	9	8			*	2	8	56
Denver	39	44	105	4	2	1	1	4	6	6	4	1	6	7	4	1	45
Cheyenne	41	12	104	42					6	5	7	4	5	2	3	1	33
Fort Sully	44	39	100	40	5	1	2	4	1		1		5	3	2		24
Breckenridge	46	11	96	17	1	[illegible]	1		3	1			4	1	1	3	19
Yankton	42	45	97	30	[illegible]	1		2					4	3	1		15
Geneva	42	53	77	5	2			1	4	4	*	*	*				11
San Antonio	29	25	98	25	3	1		6								1	10
Pembina	49	0	97	5		1	1		3				2	1	1		9
Fort Garry	49	52	96	58		2		2	1					1	1		7
Stayner	44	25	80	15	1			1	3	1				*			6
Fort Gibson	35	43	95	16	1									1	2	1	5
Chatham	47	1	65	30		2	2										4
Halifax	44	40	63	35		1	1									1	3
La Crosse	43	48	91	23		2			1								3
Morgantown	39	36	79	52				1						2			3
Leavenworth	39	19	94	58												2	2
Mt. Washington	44	16	71	16	2												2
Ottawa	45	22	75	45					1	1							2
Sydney	46	18	60	9			1		1					*			2
Wytheville	36	56	81	0	*	*	*	*				1	1	*	*	*	2
Albany	42	40	73	45					1					*	*		1
Buffalo	42	53	78	55		1											1
Burlington	44	29	73	15												1	1
Charleston	32	45	79	55								1		*	*		1
Davenport	41	32	90	38											1		1
Duluth	46	48	92	8	*	*	*	*	1					*	*	*	1
Eastport	44	55	66	54	1									*	*		1
Erie	42	7	80	10	1					*	*						1
Kingston	44	12	75	41												1	1
New London	41	22	72	9	*	*			1					*	*	*	1
Norfolk	36	51	76	19					1					*	*		1
Omaha	41	16	96	0	1												1
Portland, Oreg.	46	30	122	27	*	*	*	*	*	1				*	*	*	1
Port Stanley	42	40	81	13	*	*	*	*		1				*	*	*	1
Saugeen	42	40	81	16					1					*			1
Squan Beach	40	6	74	1	*	*								*	*	1	1
Saint Louis	38	37	90	15	1												1

The number of stations at which a difference of 40° between the maximum and minimum of the same day was observed in 1874, is 38, which is 35 per cent of the whole number of stations; and among the stations at which so great a difference did *not* occur, are Kingston, Toronto and Montreal, in Canada, and Pike's Peak, at an elevation of 14,092 feet above the sea.

From the preceding tables it appears that throughout the greater part of the United States there is occasionally observed a difference of 40° between the maximum and minimum temperature of the same day, and there are a few places where such changes are remarkably frequent. This phenomenon occurs most frequently at stations situated between the Mississippi River and the Rocky Mountains, and at the head of the list stand Colorado Springs and Denver. Colorado Springs is situated on the eastern side of Pike's Peak, at an elevation of 5,935 feet above the sea, and Denver is distant from it about 60 miles on the eastern slope of the Rocky Mountains, at an elevation of 5,135 feet.

These cases of great diurnal change of temperature result from the ordinary diurnal change combined with the effect due to the passage of a great storm; and the sudden fall of temperature, which frequently succeeds a great storm, I think cannot be fully explained without admitting the sudden descent from a great height of air whose temperature is unusually low. The proximity to mountains appears to favor this sudden descent of air from a great height. Colorado Springs and Denver are situated where the upward and downward motion of atmospheric currents must be uncommonly frequent, and they surpass all the other stations of the signal service in the magnitude and suddenness of the changes of temperature. An instance of this kind has recently been reported which is the most remarkable I have ever known. I have received a statement of the facts from three different sources, all of which agree in the main, but they show differences of several degrees of temperature, which may be ascribed to a difference in the exposure of the instruments. The most moderate statement is that furnished by the observer at the U. S. signal service station, and I will therefore adopt his numbers in preference to either of the others.

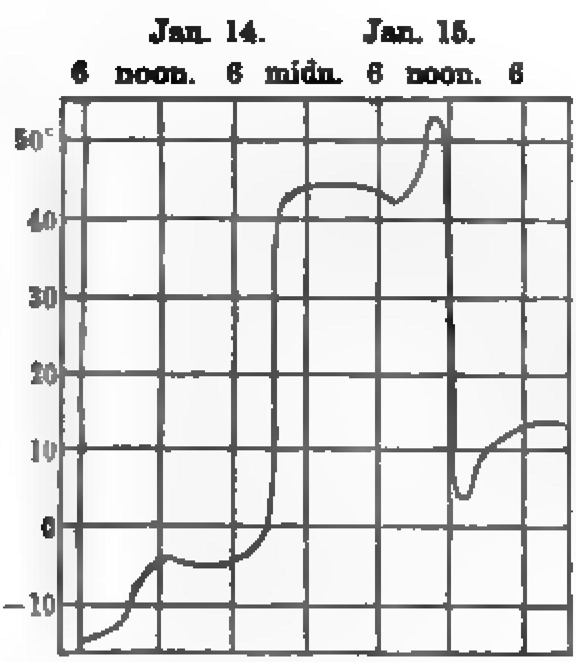
Storm of Jan. 15, 1875, *at Denver, Colorado.*

On the 14th of January, 1875, the thermometer at Denver had been below zero all day, with a variable northeast wind. At 9 P. M. of that day the thermometer was one degree above zero. The wind then veered suddenly to southwest; and at 9.15 P. M. the thermometer stood at 20°; at 9.20 P. M. it stood

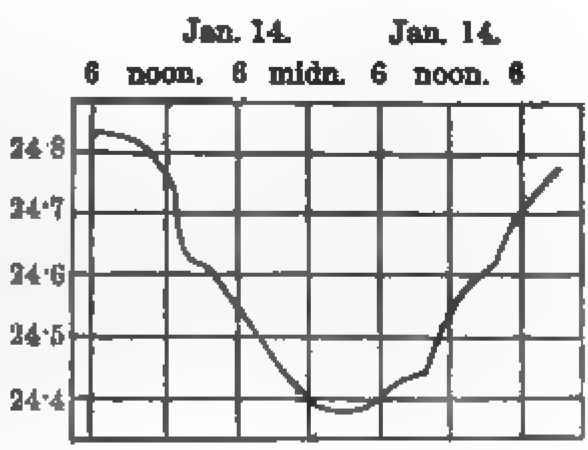
at 27°; at 9.30 P. M., 36°; and at 9.35 P. M. at 40°; after which there was but little change till near noon of the next day. The preceding observations show a rise of the thermometer amounting to 39 degrees in 35 minutes.

On the 15th of January, the thermometer had been above 40° all the morning, with a fresh southwest wind. About 11.30 A. M. the thermometer stood at 52°. The wind then suddenly backed to northeast, and at 12.30 P. M. the thermometer stood at 4°; being a change of 48° in one hour. Another observer, who is pronounced perfectly reliable, says that between 11 A. M. and noon a thermometer fell from 58° to 22° (that is, thirty-six degrees) in five minutes. The annexed figure on

Thermometer.



Barometer.



the left will perhaps give a better idea of the extent and suddenness of these changes of temperature than would be derived from a simple description. The entire curve shows the state of the thermometer for nearly two days, from 5.43 A. M., Jan. 14th, to 9 P. M., Jan. 15th, according to the observations made at the signal service station. The figure on the right shows the changes in the pressure of the atmosphere during the same period. On the 14th the barometer fell from 24·83 to 24·40 inches, and on the 15th it rose again to 24·76 inches.

These changes of temperature and pressure which were noticed at Denver, were the effects of a considerable storm which came from the northwest, and whose center passed on the east side of Denver, within about 250 miles of that place. This storm was accompanied by high winds and gales in Colorado and Kansas. It probably did not differ materially from the winter storms frequently experienced in other portions of the United States, except in the extreme suddenness of the

changes of wind and temperature. I do not think that these sudden changes can be fully explained by the supposition of a polar current sweeping along the earth's surface from a higher to a lower latitude, but it seems necessary to admit a sudden transfer of very cold air from a higher to a lower level. The heat of Jan. 14th probably resulted from the sudden precipitation of vapor caused by the elevation of air from the earth's surface; and this warm air near the earth's surface suddenly ascended on the 15th, being displaced by the colder air of a greater elevation.

In preparing the materials for this article, I have been assisted by Mr. Edward S. Cowles, a graduate of Yale College of the class of 1873.

ART. II.—*Preliminary Note on a Magnetic Proof Plane*; by HENRY A. ROWLAND.

ABOUT four years ago I made a large number of experiments on the distribution of magnetism on iron and steel bars by means of a coil of wire sliding along the bar; the induced current in the coil as measured by a galvanometer was a measure of the number of lines of force cut by the coil and can be found in absolute measure by my method of using the earth inductor. These researches have never yet been published owing to circumstances beyond my control, but are known to quite a number of persons in this country, and will soon be published. The method there used is the only correct one that I know of for experimenting on magnetic distribution, and my purpose in this note is to extend it to bodies of all shapes, so that experiments on magnetic distribution may become as simple and easy to perform as those on electrical distribution. And so well has my magnetic proof plane accomplished this that I can illustrate the subject to my classes with the greatest ease.

The apparatus required is merely a small coil of wire $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, containing from 10 to 50 turns, and a Thomson galvanometer. When we require to reduce to absolute measure, another coil about a foot in diameter and containing 20 or 30 turns is required. Having attached the small coil (or, as I call it, the magnetic proof plane) to the galvanometer, we have merely to lay it on the required spot, and when everything is ready, to pull it away suddenly and carry it to a distance, and the momentary deflection of the galvanometer needle will be proportional to that component of the lines of force at that point which is perpendicular to the plane of the coil. And if we apply it to the surface of a permanent magnet the so-called

surface density of the magnetism at that point will be nearly proportional to the deflection. In the case of an electro-magnet the surface density will be nearly proportional to the deflection minus the deflection which would be produced by the helix alone, though the last is generally small and may be neglected. I use the words *nearly* in the above statement because they are only exactly true in the cases where the lines of force proceed from the surface in a perpendicular direction; otherwise the deflections must be multiplied by the secant of the angle made by the lines of force with the surface of the magnet. In the case of an electro-magnet made of very soft iron, theory shows that the lines pass out nearly perpendicular to the surface and so no correction is needed.

We can also, by a coil of this kind, determine the intensity of the magnetic field at any point and thus be able to make a complete map of it. Having done this, we have all the data necessary to substitute in the formula which I have given in this Journal,* and by a simple experiment can thus determine the coefficient of magnetization of any diamagnetic or weak paramagnetic body probably in a more accurate manner than any Weber used. Only the largest-sized magnets could of course be used for this purpose with any accuracy, and indeed they are always to be preferred in obtaining the distribution by this method.

Having obtained the distribution for any given magnet, the distribution for any similar magnet of the same material but of different size becomes known by a well known law of Sir William Thomson.

As, in the present state of our knowledge, magnetic measurements are of small value unless made on the absolute scale, we require to reduce our results to this system. There are several methods of doing this, but the simplest is that which I have used in my experiments on magnetic permeability, and consists in including an earth inductor in the circuit. A coil laid on a perfectly level surface is sufficient for this: when this is turned over, the induced current will be equal to $C=\frac{2nVA}{R}$, where n is the number of turns in the coil, A its mean area, V the vertical component of the earth's magnetism, and R the resistance of the circuit. When the small coil is pulled suddenly away the current will be $C'=\frac{n'Qa}{R}$, and so we have $Q=2V\frac{AnC'}{an'C}$, in which when a Thomson galvanometer is used C' and C can be replaced by the corresponding deflections; hence $Q=2V\frac{AnD'}{an'D}$, in which a and n' are the area and number of turns in the small

* On a new diamagnetic attachment to the lantern, &c., this Journal, May, 1875.

coil and Q is that component of the magnetic field we are measuring in the direction of the axis of the small coil.

As an illustration of this method I will give a few experiments made with the magnets of a Ruhmkorff diamagnetic apparatus, which was altogether about 2 ft. long and had its magnets 2 in. in diameter, with a hole ½ in. in diameter through them for experiments on the rotation of the plane of polarization of light, but which in these experiments were closed by the solid poles which were screwed on. The first experiments were with two discs of iron, 4·6 in. in diameter and 1⅝ in. thick, screwed on to the poles. In the first place the poles were turned away from one another, the current being sent through only one magnet, and the values of the magnetic field obtained at different points close to the surface of the disc. These may be numbered as follows: No. 1, at center of face of disc; No. 2, on face of disc half an inch from the edge; No. 3, on center of edge of disc. The measures are on the meter, gram, second system.

1st. Strength of current, 4·4 farads per second.

1. 2220. 2. 3550. 3. 4440.

2nd. Strength of current 8·3 farads per second.

1. 3600. 2. 5300. 3. 7500.

Next the poles were turned toward each other and the current sent through both magnets, so as to make the poles of the same name. Current 4·6 farads per second.

1st. Distance of poles, 3 in.

1. 1300. 3 3800.

2nd. Distance of poles, 1½ in.

1. 600. 3. 4000.

Here we see an approach to one of Faraday's places of no magnetic action.

After this the current in one of the magnets was reversed so as to make the poles opposite. Current the same.

1st. Distance of poles, 3 in.

1. 5800. 2. 8200. 3. 6700.

2nd. Distance of poles, 1½ in.

1. 9800. 2. 7500. 3. 5800.

It is curious to note how the distribution changes with the distance of the discs; thus, on one disc free from the other, the edge of the disc has the greatest magnetic surface density, but when the two discs form opposite poles and are 3 in. apart, position 2 gives the greatest effect, while, when they are 1½ in. apart, the field is greatest at the center. This entirely agrees with theory.

conical poles for diamagnetic experiments were then
d on. These were portions of cones with an angle at
of about 60°, with the vertex considerably rounded off.
vere one inch apart and the poles were opposite. Cur-
4 farads per second.

:enter of field between the poles,	12500
he axis near one pole,	32100
:one one inch from vertex,	11000
:ylindrical portion of magnet 2½ inches ɔm the vertex of the cone,	5800

se poles were now replaced by frustums of cones with
ds, the original diameter of the iron, 2 inches, being re-
at the end to 1½ inches, and they were placed ¼ inch
The field in this case between them was 61000, or
up to the maximum of magnetization of nickel at com-
:mperatures, and above that at high temperatures.

April 1, 1875.

III.—*On Pseudomorphs of Chlorite after Garnet at the rr Mountain Iron Mine, Lake Superior;* by RAPHAEL IPELLY. With Plate II.

CDOMORPHS of garnet occur in abundance in a bed of
ic schist, just overlying the great magnetite bed of the
Michigamme iron range.*

: schist is of Archæan age and belongs in the upper beds
Huronian iron series. It is a very fine-grained, dark
chlorite, which gives a light green streak and powder,
es in acids leaving a deposit of silica, and fuses B.B. on
ʒe to a black magnetic enamel (fus. = 4.) It is impreg-
vith octahedrons of magnetite, which rarely reach a diam-
one-eighth inch. Throughout the rock are scattered the
morphs in very sharply defined rhombic-dodecahedrons of
ɜs below 1½ inches in diameter. Often perfect crystals
easily detached from the matrix.

ɔreaking the crystals and polishing the surface of fracture,
re found to be changed more or less to chlorite, in some
:es specimens an inch in size containing not more than five
ɪt of garnet, while in others 30–50 per cent of unaltered
.l is present.

octahedral crystals of magnetite are scattered through
eudomorphs. They are visible to the naked eye, half

* ı indebted to Dr. Cobb, the agent of the mine, and to Col. F. Norvell, ɑanager, for several hundred fine specimens of these pseudomorphs.

imbedded on the surface planes, and in the interior of the crystals, both in the chlorite and in the unaltered garnet.

I have made several thin sections passing through the middle of crystals, about one inch in diameter, and have studied them under the microscope, making such examination of the optical characteristics as the nature of the minerals and the limitations of the method would permit.

Under a one-tenth inch objective (500 diameters) the garnet appears not to be strictly homogeneous in texture; it has a curdled structure, particles of a transparent bluish-white filling the irregular meshes of a less clear, white net-work. Both of these portions of the garnet are isotrope, remaining dark through a full revolution between crossed nicols. Throughout both of these members are scattered exceedingly minute particles of a transparent red substance (hematite?) and larger opaque grains and discoidal plates.

A glance at a section under a low power shows that the change has taken place by an attack on the garnet along the countless fissures that traverse it in every direction (fig. 1), progressing most rapidly in the larger cracks, and ramifying through the more minute ones.

Two substances, one greenish-yellow, the other clear green, seem at first sight to be among the products now forming the pseudomorphs, though, as we shall see, they both probably belong to the same mineral.

I. The slightly greenish-yellow mineral (fig. 1) surrounds the remaining garnet fragments in bands which are in places clear and transparent, and in others are marked with longitudinal wavy lines, which probably indicate the cleavage of the mineral. From these broader bands, narrow ones branch off to form an intricate net-work in the garnet fragments. The same mineral occurs in isolated and grouped, long and slender crystals, which often branch out from or intersect the bands; while in other places the bands are often made up of these crystals, arranged more or less parallel to each other.

These bands are generally $\frac{1}{1000}$ to $\frac{1}{100}$ of an inch wide, and under a low power (figs. 1 and 2) their edges are sharply defined. Where a garnet fragment has been entirely destroyed, its place is occupied by an interwoven mass of them, often associated with irregular patches of the green substance described below. Under a high power, both the transparent red particles and the opaque grains and plates that were noticed in the garnet, are observed in this alteration-product.

These bands, when observed with only one nicol—the polarizer—show a high degree of absorption for intensity, and an appreciable amount for color, changing from very dark (with bluish-green tint), when the longer direction is

parallel to the undulation plane of the nicol, to very light (with greenish-yellow tint) when perpendicular to that plane. Assuming that the parallel sides of the bands are crystallographic outlines and that they lie either in the basal plane, or else parallel to the principal crystallographic axis, I have attempted to determine optically the system to which these crystals belong. The method followed is that recommended by Tschermak in distinguishing pyroxene, hypersthene and biotite. Having carefully adjusted the microscope,* so that the cross hairs in the ocular coincided exactly with the undulation planes of the crossed nicols, I first selected an individual, generally a long one with straight sides, and brought it by means of one of the cross-hairs into parallelism with the undulation plane of one of the nicols, and then revolved the stage till the nearest point of maximum darkness was reached, when the principal sections of the crystal coincided each with a principal section of a nicol's prism. The number of degrees of this revolution indicate the inclination of the principal sections of the crystal to the crystallographic feature chosen for reference.

Of course, if the mineral were either uniaxial or orthorhombic, the maximum of darkness would occur when two of the axes of the crystal were parallel to the undulation planes of the nicols, and there would be no revolution required. But this could occur in a monoclinic crystal only when one of the principal sections happened to coincide with the plane of symmetry; in every other position the axes of the crystal would make with its principal sections an angle which would vary between 0° and the number of degrees representing the inclination of the bisectrices to the vertical and inclined lateral axes; the full amount of this inclination could only be observed when the principal sections of the crystal were perpendicular to the plane of symmetry, but any inclination suffices to determine that the crystal belongs to a clinobasic system. Observations on a great number of the bands and isolated crystals failed to show any inclination; the mineral, therefore, does not belong to a clinobasic system.

II. The clear green portions occur isolated in the garnet fragments, and in places in the fissures with the mineral last described, and more or less diffused through the larger bands, but more generally in irregularly-shaped spots, and with outlines which are not necessarily determined by those of the garnet fragments. These larger areas exhibit lamellar aggregate polarization both between crossed nicols and with the polarizer alone. Between crossed nicols portions remain

* One of Beck's first class binoculars, in which the polarizer is attached to a sub-stage, and the main stage is graduated.

wholly dark during a revolution, some show only a faint change, and others are not distinguishable from the substance forming the bands, except that the cleavage lines are not so distinct. So also with one nicol, the portions that remain dark between crossed nicols show no absorption, while other portions change from clear green to almost colorless faint green-yellow, and still others show about the same changes as the bands.

Again, we find in places, on the same individual, all these conditions, shading gradually one into the other in a manner that seems to indicate a bent crystal. I am inclined to look upon the bands and the clear green as identical, and as belonging to a hexagonal chlorite. The green portions would then be those which were cut more or less parallel to the basal plane, and the dichroitic bands those cut perpendicular to this.

While the plane of contact between the chlorite bands and garnet appears sharp under a low power, higher objectives (one-tenth or one-sixteenth inch) show it to have a rough surface caused by the projection of countless chlorite points into the garnet substance, in a manner that leaves on the observer the impression that the attack is facilitated in some way by the curdled structure of the garnet.

The chloritic schist which encloses the pseudomorphs consists apparently of exactly the same chlorite, the only perceptible difference being that in the schist the individuals are very minute, averaging ·00015 inch thick by ·0005 long, with scattering aggregations of crystals ·0008 by ·004 inch.

The optical characteristics of these larger, and so far as determinable, of the smaller, are identical with those of the chlorite in the pseudomorph.

The only other substances observed in the schist are minute octahedrons of magnetite and the discoidal plates which occur indifferently throughout the schist, the garnet substance, and the pseudomorphous chlorite. These plates average about ·00025 inch thick by ·00075 in diameter, and in reflected light have metallic luster. They are not attracted by the magnet and show no change after continued boiling in sulphuric and in muriatic acids. I had at one time the impression that they were graphite, but on comparing them with microscopic plates of that mineral in the Port Henry limestone, the difference in luster and fracture appeared very great.

These minute plates appear to me to be older than either the garnet or the chlorite—to have been enclosed in the original rock (argillaceous limestone?), and to have resisted the changes which successively produced the garnets and destroyed these and substituted chlorite for them and the original rock.

If this view is correct, the paragenesis should be as follows:

I. Original Rock (*Marl?*)

. Metamorphic Change with crystallization of
  (*a.*) Octahedrons of *magnetite* and the *discoidal crystals.*
  (*b.*) Garnets.
I. Pseudomorphic Change. *Chlorite* after the original rock and after garnet, but preserving the magnetite and discoidal crystals intact.

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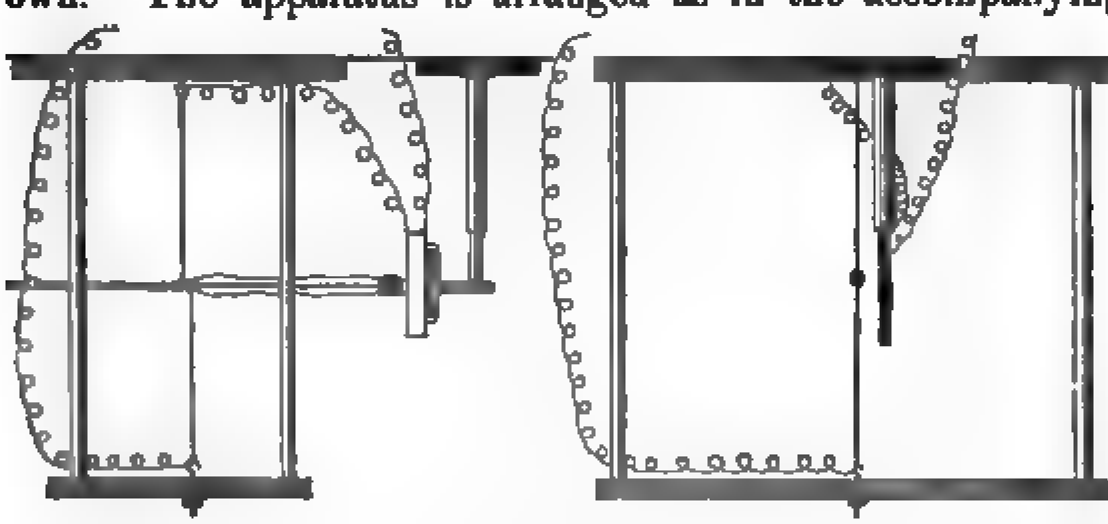
rt. IV.—*Brief Contributions from the Physical Laboratory of Harvard College.* No. 18.—*An Application of the Horizontal Pendulum;* by Harcourt Amory.

The paper on the horizontal pendulum published by Zöll-r, in Poggendorf's Annalen, suggested the following applica-n of the instrument to proving Ampère's laws of the attraction d repulsion of currents. To prove these laws, the circuit iich the current traverses must consist of two parts, one fixed d the other movable. The apparatus devised by Ampère is fficult to make. By the use of the horizontal pendulum, owever, the mutual action of the currents can be readily own. The apparatus is arranged as in the accompanying



gure. The wire which forms the upper support of the pendu-m is connected with one pole of a battery, and is then led ong the horizontal bar of the pendulum, best made of glass, d is bent in the form of a parallelogram at the extremity of e bar. The wire is then led back to form the lower support the pendulum, and is then connected with the other pole of e battery through a fixed coil of wire placed in the neighbor-od of the end of the pendulum.

The current first passes to the upper suspending wire, around e parallelogram at the extremity of the pendulum, back rough the lower supporting wire, through the outside coil, d returns to the battery. By turning the outside coil upon a rizontal axis, the laws of attraction or repulsion of rectilinear rrents can be shown. The apparatus is peculiarly well apted to show the action *of solenoids* upon each other.

ART. V.—*Explosive Properties of Methyl Nitrate;* by M. CAREY LEA, Philadelphia.

SEVERAL dangerous accidents have recently occurred in the manufacture of methyl nitrate, one of them unfortunately resulting in the death of Mr. Chapman. This, and the remarks recently published on the subject by M. Girard, the well-known French chemist (an abstract of which lately appeared in the pages of this Journal), leads me to make a few observations on this subject.

When I first attempted to prepare this substance by the only method published up to that time, I felt convinced that the chances were greatly in favor of an accident, though no warning was given in the text books. I therefore wore a mask, and operated cautiously with moderate quantities in a very large flask. A tremendous explosion followed, in which the flask entirely disappeared; no fragment of the body could be found. I then tried the use of urea in the same modified manner which I had proposed in the case of ethyl nitrate. The operation was entirely successful, and was many times repeated without any trouble or difficulty. And it is, I presume, in this way that it is now commercially manufactured on a large scale.

Within the last few days I have made the following experiments on its explosive properties.

Contrary to what has been stated, I do not find it liable to explode by percussion. Some extra thick filtering paper was saturated with it, was placed on a piece of iron, and forcibly struck with a hammer. This was repeated a dozen times, until the paper was broken to pieces, without explosion.

Five or six drops were placed in a test tube; this was placed in a deep cup, and a little alcohol poured into the cup and inflamed. In this way the flames played chiefly on the surface of the test tube above the liquid, thus preventing its escape by evaporation at low temperatures. A slight explosion followed, which did not break the test tube.

When ethyl nitrate was similarly treated, it quickly evaporated without explosion.

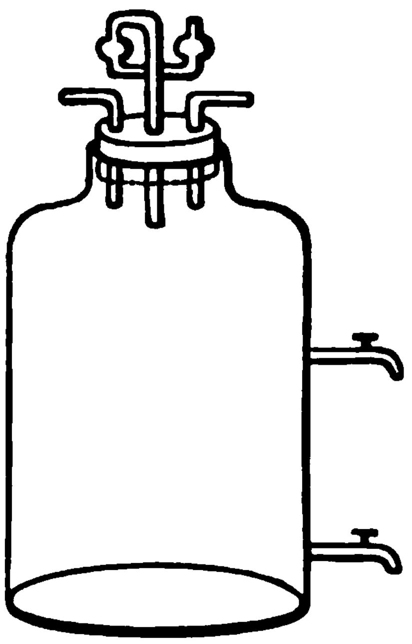
Twenty measured minims of methyl nitrate were then placed in the tube, and the experiment repeated. A moderate explosion followed, breaking the tube.

The same quantity as in the first experiment, five or six drops, was placed in the test tube, and dry sand added more than enough to absorb the liquid. The heat was applied in the same way as before, but the explosion was not greater than without the sand, except that the tube was broken.

When poured on filtering paper and inflamed, it burns quietly with a peculiar livid flame.

These trials do not seem to indicate a very violent explosive power. Nevertheless, the unfortunate experience which has been already gained sufficiently indicates that it is not a substance to trifle with. Indeed, a liquid whose vapor explodes at 150° C., as determined by Dumas and Peligot, cannot be otherwise than dangerous, especially when handled in large quantity. Having been the first person to prepare this substance in any quantity, and having had occasion to study carefully its conversion into the methyl ammonias, it occurs to me that as these substituted methyl compounds are now used on a large scale, a few suggestions toward a safe method of managing the operation for large quantities may be acceptable.

I would propose to construct a receptacle in which to receive the methyl nitrate vapors as they are distilled over, of the shape shown in the margin, a cylindrical vessel with a large mouth and two faucets, one near the bottom, the other a little above the middle.



To commence the operation, the vessel should be filled one-third full with lumps of ice. The cover should then be closely fitted on with a safety tube, and a third tube connecting with another similar vessel.

As the partly condensed mixed alcoholic and ethereal vapors come over, the products of distillation are cooled by the ice, and the water resulting from its melting precipitates the ether. This last can be from time to time drawn off by the lower faucet, into stoneware bottles already containing a proper quantity of strong ammonia and alcohol. When one-third full of the ingredients in the proper proportions, these bottles should be securely closed, and placed for several days at a temperature of about 90° F., until decomposition is complete.

The upper faucet shown in the cut is to draw off the mixed water and alcoholic distillate which accumulates in large quantities over the ether, and which otherwise would impede the operation.

In the process as above described, the methyl nitrate would be destroyed almost as soon as formed. As soon as any considerable quantity has passed over, it could be transferred into the vessels in which, by contact with ammonia, decomposition begins, and this without interrupting the distillation. If desired, sodium carbonate can be placed in the condensing vessel to remove any nitric acid that may adhere to the methyl nitrate. But the presence of a little acid is not important in the decomposing jar; it would be converted into ammonium nitrate, and as this salt is always formed to some extent by the action of

methyl nitrate on ammonia, the presence of a fraction more or less would be unimportant.

I am inclined to believe that in the manner described, the danger in the preparation of this substance will be reduced to a minimum, a matter of some importance, as the quantity consumed in the manufacture of the methyl violet seems likely to be increasingly large. A good cooling apparatus between the retort or still and the receiver here figured would be necessary.

W. Weith has just published* an interesting communication on the formation of methyl-ammonias by the action of excess of methyl alcohol on sal ammoniac, which at 285° C. was completely converted into methyl ammonias. This method of methylizing ammonia may perhaps take the place of mine: it is, however, liable to two objections; first, that a considerable proportion of the methylic alcohol is, according to Herr Weith, lost by conversion into methyl ether; secondly, the high temperature and pressure necessary. I found that methyl nitrate, unlike ethyl nitrate, does not require pressure vessels, but reacts at or near the ordinary temperature and pressure. My own operations were performed in large stoppered vials set on the cooler part of a sand bath, where the temperature did not rise above 90°. The loss by formation of methyl ether may perhaps be compensated by the fact that in the formation of methyl nitrate there is always loss of both methylic alcohol and nitric acid.

Philadelphia, May 17, 1875.

ART. VI.—*Contributions from the Sheffield Laboratory of Yale College.* No. XXXIV.—*On Zonochlorite and Chlorastrolite;* by GEORGE W. HAWES.

AT the meeting of the American Association for the Advancement of Science which was held at Dubuque, Iowa, in 1872, Prof. A. E. Foote described "a new hydrous silicate" found at Neepigon Bay, on the north shore of Lake Superior.† It is a hard, green mineral occurring in the amygdaloidal trap, associated with calcite, quartz, and various zeolites; and it is also found in the form of smooth water-worn pebbles upon the shore. This mineral, on account of its structure, he called *Zonochlorite*, since many of the specimens are beautifully banded; and his analysis convinced him that it was a zeolite. The stones which he regarded as pure were of a uniform dark green color; while

* Bericht Deut. Chem. Ges., 26th Ap., 1875.

† Proceedings of the American Association for the Advancement of Science, 21st meeting, August, 1872, p. 65.

those which were very plainly banded with white he considered impure. But thin sections of some of the dark green stones, received from Prof. Foote, and considered by him as the purest zonochlorite, when examined under the microscope, show that these, like the other specimens, are more or less banded and consist of green earthy particles disseminated through a white mineral. A dark green specimen gave me, on analysis, the following composition:

Silica	35·94
Alumina	19·41
Ferric oxide	6·80
Ferrous oxide	4·54
Lime	22·77
Magnesia	2·48
Soda	*trace*
Water	8·40
	100·34

The analysis indicates that the mineral is a very impure variety of prehnite, a mineral which is common in the trap of that region; and its hardness and behavior before the blowpipe point to the same conclusion. The analytical results obtained by Prof. Foote show that the material he examined was not homogeneous, as he states that the percentage of water, the average of which was 8·7, varied from 7·03 to 12·9. The presence of magnesia shows that a portion of the impurity is chlorite.

Zonochlorite in its mode of occurrence resembles *Chlorastrolite*,* which is found on the shores of Isle Royale in rounded pebbles derived from the amygdaloidal trap, and has also been found *in place* in the trap. At the suggestion of Prof. Brush, who placed at my disposal the specimens which were brought by him from Lake Superior, thin sections were made from some of the best stones in his possession: and the microscopic examination of these made it very evident that chlorastrolite is not a homogeneous substance—the impurities in this case being distributed through a white mineral of a radiated structure; and to the irregular arrangement of the pure and impure material the stone owes its beauty. When a flat surface is cut upon one of these stones, the polished face presents various shades of green; but when the other side is cut away, thus making a thin section of the stone, those spots which have the deepest green are found to be perfectly clear and white, receiving their deep green shade from the colored surfaces beneath. The green

* Boston Journal of Natural History, vol. v, p. 488. Report on the Geology of the Lake Superior Land District, Part II, p. 97. Dana's Mineralogy, 5th edition, p. 412.

impurities are arranged along lines radiating from these clear centers, till at some distance the mixture becomes so intimate as to appear nearly homogeneous until more highly magnified. An analysis of a very fine stone gave the following result:

	I.	II.
Silica	37·41	
Alumina	24·62	
Ferric oxide	2·21	
Ferrous oxide	1·81	
Lime	22·20	
Magnesia	3·46	
Soda	·34	·30
Water	7·72	
	99·77	

The essential difference between this analysis and those by Prof. J. D. Whitney is, that the percentages of magnesia and soda have exchanged places, since he obtained no magnesia and 4 per cent. of soda. For this reason, I repeated my alkali determination upon another sample prepared from portions of several stones, but with no variation in the result, as will be seen in No. II above. This great difference can be accounted for in no way save by the evidence, which the microscopic examination affords, that the stones are mixtures of minerals which have been carried into the amygdaloidal cavities of the trap. The stones that I have seen appear to consist, like the zonochlorite, largely of impure prehnite. The higher specific gravity may be due to an enclosure of epidote, which is everywhere associated with the chlorastrolite in the rocks, and moreover is often present in the same cavity.

ART. VII.—*Contributions from the Sheffield Laboratory of Yale College.* No. XXXV.—*On Glycogen and Glycocoll in the Muscular Tissue of Pecten irradians*; by R. H. CHITTENDEN, Assistant in Physiological Chemistry.

THE genus Pecten is world-wide in its distribution. The species *irradians* is entirely American, being found most abundantly on the eastern shores of the United States. It is closely allied to the European and English species *opercularis* and *maximus*. The large central muscle which closes the valves of this mollusk is highly valued as an article of food, although its peculiar sweet taste is objectionable to some.

With this central muscle the following experiments were made:

Glycogen.—By extracting the edible portion of the scollop with cold water, a milky opaque fluid with slight acid reaction is obtained, and an insoluble residue consisting principally of syntonin or fibrin mixed with inorganic matters. The strong opacity of the aqueous solution is not due to an emulsion of fatty matters. On boiling the solution with or without the addition of acetic acid, a large amount of albumin is precipitated, leaving the fluid still opalescent. On treating the fluid, after the removal of albumin, with a small amount of ninety-five per cent alcohol, a light flocculent precipitate is obtained which dissolves by agitation, leaving the fluid unaltered in appearance; but if three or four volumes of the alcohol are added, a copious, permanent precipitate settles, leaving the supernatant fluid perfectly clear. This precipitate is of snowy whiteness, except when previous to precipitation the fluid has been boiled considerably, in which case both filtrate and precipitate assume a yellow or brownish color, from which the latter can be freed by solution in cold water and reprecipitation by alcohol. The precipitate, if allowed to dry in contact with air, after having been washed with alcohol merely, soon becomes translucent on the edges and finally is transformed completely into a gummy mass, which is sticky when moistened; but if after precipitation it is washed with ether thoroughly, it loses this property of becoming gummy, which seems to be due to the presence of water and of albuminous matters in small quantity. This gum-like mass when hard is brittle and yields on trituration a white hygroscopic powder showing under the microscope no distinct structure. A portion of the precipitate so prepared, dried in the air, yielded by analysis:

	1.	2.	Calculated. $C_6H_{10}O_5 + H^2O$ or $C_6H_{12}O_6$
C	39·52	39·56	40·00
H	6·62	6·55	6·60
O	53·86	53·89	53·34

In this state it is not quite pure, giving with Millon's reagent a strong reaction for albumin and containing some inorganic matter, one specimen 1·57 per cent, another 1·38 per cent, consisting in all cases, so far as were examined, of calcium phosphate. From this analysis it is seen that the substance has the formula of the sugars, or that of the starch group plus a molecule of water. The substance is tasteless, gummy when moistened and gives an opaque fluid with water, seemingly a true solution, which passes unchanged through filter paper and animal charcoal, and shows no particles under the microscope with a half inch objective. When this aqueous solution is boiled, thin films separate, forming a scum on the top of the fluid, which goes into solution again as the liquid becomes cool.

The substance is insoluble in alcohol and ether, has no reducing action with cupric sulphate and sodium hydroxide, but when boiled with a few drops of dilute hydrochloric acid gives a clear fluid which has strong reducing action. This same reaction takes place also with nitric and sulphuric acids, but not so readily as with the former. A portion of the substance was treated with a small quantity of saliva at the ordinary temperature, and at 40° C., and in both cases the ptyalin acted immediately upon it and sugar was formed. Treated with a solution of iodine in potassium iodide, a brownish red or maroon color was obtained. These and other reactions pointed to glycogen. It was yet to be ascertained whether the sugar formed by the action of acids and ferments was glucose, also to examine the action of boiling dilute nitric acid upon it, and to determine whether the different formulæ of glycogen could be obtained by drying it at different temperatures. A portion of the substance was then boiled with hydrochloric acid until alcohol produced no precipitate in a sample tested, the excess of acid removed by oxide of silver and the sugar obtained by evaporation. The product had all the properties of glucose, was intensely sweet, reduced alkaline solutions of copper and silver and yielded Pettenkofer's reaction. Analyzed, it gave the following result:

	1.	2.	Calculated. $C_6H_{12}O_6+H_2O$
C	36·15	36·17	36·36
H	6·82	6·88	7·07
O	57·03	56·59	56·57

By the action of boiling dilute nitric acid, oxalic acid was formed and separated. A different sample of the original substance, dried over sulphuric acid until a constant weight was obtained, yielded:

	1.	2.
C	43·81	43·90
H	6·43	6·46
O	49·76	49·64

A sample dried at 100° C. gave by analysis:

	1.	2.	Analysis of starch dried at 100° C. by Mulder
C	43·86	43·89	43·86
H	6·41	6·38	6·28
O	49·73	49·73	

A sample dried at 140° C.:

	1.	2.	Analysis of starch dried at 140° by Mulder
C	44·32	44·40	44·47
H	6·38	6·41	6·28
O	49·30	49·19	

On treating an aqueous solution of the substance at the ordinary temperature with an excess of a saturated solution of

barium hydroxide, a heavy white precipitate was obtained, soluble in water, insoluble in baryta water and alcohol. This precipitate was dissolved in water, the baryta removed by a little dilute sulphuric acid in the cold and then reprecipitated by an excess of alcohol.

Prepared thus, it seemed to have lost the property of becoming gummy so readily as before, and on examination was found to be completely free from albuminous matters, giving no reaction even with Millon's reagent and also contained only 0·61 per cent of ash. The substance dried at 100° C. gave by analysis the following result, agreeing closely with that of the preceding preparation dried at the same temperature:

	1.	2.
C	43·93	43·91
H	6·45	6·40
O	49·62	49·69

Another sample, prepared in the same way and dried between 110°–120° C., gave:

	1.	2.
C	43·56	43·63
H	6·71	6·71
O	49·73	49·66

Casting a backward glance, we see that the analysis of the air-dried substance corresponds with the formula $C_6H_{12}O_6$, that of the substance dried at 140° C. with $C_6H_{10}O_5$, which requires 44·44 C. 6·11 H. These results agree with glycogen, which in different states of hydration has been found to have the formulæ $C_6H_{10}O_5$, $C_6H_{12}O_6$ and $C_6H_{14}O_7$. But the results obtained by the analyses of the substance dried at 100° C. and 110°–120° C. do not agree closely with any of the above formulæ. The same is true of members of the starch group to which glycogen is closely related, and lately Dr. Nägeli * has published a paper in which he points out that the elementary composition of starch, dextrin and "amylo-dextrin" dried at temperatures not exceeding 116°, agrees better with the formula $C_{36}H_{62}O_{31}$, which requires 43·63 C. 6·3 H, than with $C_6H_{10}O_5$, and that after exposure to a temperature of 140 C., when the composition corresponds to $C_6H_{10}O_5$, we probably do not deal with undecomposed starch. The analysis of amylo-dextrin by Nägeli (loc. cit. p. 35), dried in a stream of hydrogen, at a temperature of 112° to 116° C, gave the following result:

	1.	2
C	43·58	43·85
H	6·86	6·58

* Beiträge zur näheren Kenntniss der Stärke Gruppe. Dr. Walter Nägeli. 1874.

A sample of dextrin dried at the same temperature gave Nägeli as a mean of two analyses, C. 43·52. H. 6·78, in both cases agreeing closely with my analyses of glycogen dried at 110°–120° C. Thus this substance, which is without doubt glycogen, coincides in this respect with its neighbors, dextrin, amylo-dextrin, etc.

A sample of glycogen, prepared by the preceding methods and dissolved in water, on treatment with basic lead acetate, with the application of a gentle heat, yielded a heavy gelatinous precipitate, which, when filtered off by the aid of a pump and washed with water, was found to contain lead. Dried at 100° C, it gave by analysis the following result:

	1.	2.
C	21·62	21·78
H	2·91	2·96
Pb	48·39	48·34
O	27·08	26·92

Since this result was obtained, I find that M. Bizio* has already discovered glycogen in some invertebrates. Among the Mollusks, he found it in considerable quantity in the oyster. With glycogen from these sources he prepared a lead compound by means of tribasic acetate of lead, and says its "analysis has given me the formula $C_{12}H_{18}PbO_{10}$," which requires:

C	27·22
H	3·40
Pb	39·13
O	30·24

It will be seen at once that my result does not agree with this formula. I therefore made some further lead precipitates from the same and other preparations of glycogen, and in these simply determined the lead as follows:

Pb.	1st Prep.	2d Prep.	3d Prep.	4th Prep.
No. 1.	48·39	53·63	51·45	50·27
No. 2.	48·34	53·58	51·45	50·28

Some glycogen was also prepared from the liver of an ox by the usual method and dried at 100°. It yielded by analysis:

	1.	2.	Calculated. $C_{12}H_{22}O_{11}$
C	41·87	41·90	42·11
H	6·35	6·38	6·43
O	51·78	51·72	51·46

A lead preparation made from this gave:

	1.	2.
Pb	61·99	61·94

* Comptes Rendus, lxx, 175. Zeitschrift für Chemie, 1867, 745.

se results indicate that the composition of the precipitate constant.

amount of glycogen occurring in this muscular portion scollop is quite large; at one time, from three quarts :ams were obtained; at another, two quarts yielded 70

ocoll.—On evaporating the alcoholic filtrate from the itated glycogen until quite concentrated and adding neu-ad acetate, a heavy white precipitate is produced, which is bination of inorganic matters with the lead. The excess l is then removed from the filtrate by hydrogen sulphide, fter concentration the liquid is decolorized by animal al. On further evaporation the fluid deposits white pris-crystals. The crystals have a sweet taste, but upon n with soda lime, ammonia is evolved, evincing the pres-f nitrogen, which at once separates it from the saccharine The crystals first obtained were not quite pure, but reatment with animal charcoal and recrystallization gave lysis a result corresponding to the composition of glyco-Two more distinct preparations were made and gave by is:

1st Prep. 1.	2.	2d Prep.	3d Prep.	Calculated. $C_2H_3O_2NH_2$.
31·98	31·99	32·09	31·97	32·00
6·88	6·84	6·79	6·81	6·66
18·57	18·58	18·49	18·45	18·66
42·57	42·59	42·63	42·67	42·66

impurities which seemed to be the most difficult to re-were coloring and inorganic matters. The crystals were e in water and weak alcohol, insoluble in ether and te alcohol. An aqueous solution, when treated with sul-of copper and sodium hydroxide, assumed an azure blue without separation of cuprous oxide on heating. The sub-melted at about 180° C, then decomposed. With nitric ne crystals corresponding to nitrate of glycocoll were ob-. These analyses and reactions identify the substance as oll, which I believe has never before been found in .*

reparation was now made in which the alcoholic filtrate he precipitated glycogen was evaporated without the addi-f any reagents, and here the same crystals were obtained with a considerable quantity of inorganic matters and lextrose.

amount of glycocoll occurring in the tissue is small, gh where two or three quarts of material are used a fine f crystals may be obtained.

*rbuch der Physiologischen Chemie, Gorup-Besanez, page 236. 1875.

The quantitative analysis of the edible or muscular portion of the scollop, as obtained at the market, is as follows:

1st ANALYSIS.

	1.	2.
Water,	79·60	79·66
Solids,	20·40	20·34
Ash,	1·26	1·26
Nitrogenous matters (=N×6·4),	15·68	15·68
Ether extract,	·33	·28
Non-nitrog. by difference,	3·13	3·12

2d ANALYSIS.

	1.	2.
Water,	80·25	80·25
Solids,	19·75	19·75
Ash,	1·24	1·22
Nitrogenous matters,	15·04	15·04
Fatty "	·32	·24
Non-nitrog. "	3·15	3·25

Total amount of nitrogen in the substance dried at 100° C.:

	1.	2.
N	11·35	11·37

The percentage of glycogen was determined in two separate quantities.

	1.		2.	
	1.	2.	1.	2.
Glycogen,	2·43	2·40	1·98	2·19

The percentage of glycocoll was determined, but owing to the inaccuracy of the method, can be considered only as an approximation to the truth.

	1.	2.	3.	4.
Glycocoll,	·46	·68	·71	·39

The ash of the muscle consisted of the bases, soda, potash, magnesia and lime; acids, chlorine, sulphuric and phosphoric.

In conclusion, I wish to express my obligations to Prof. S. W. Johnson for advice freely given.

ART. VIII.—*Dr. Koch and the Missouri Mastodon;* by EDMUND ANDREWS, M.D., Professor of Surgery in the Chicago Medical College.

THE recent article of Professor Dana on the credibility of Dr. Koch's statement respecting the occurrence of human remains with those of the Mastodon in Missouri is a timely contribu-

ɪr many scientific men still quote Koch's testimony, as it had never been impeached. The following facts aid before the Chicago Academy of Sciences by Pro- P. Hoy of Racine, Wisconsin, a well known scientist, e whose honor and truth are above every shade of sus-

y years ago, Professor Hoy visited the spot from which ch had exhumed the skeleton now in the British Museum. ınd the men who assisted him at the work and took ccount of it. He himself also excavated and recovered ragments of the skeleton missed by Dr. Koch.

ill be remembered (see Professor Dana's article on Dr. ı pamphlets) that the discoverer of this skeleton claims e found it overlaid by one stratum of alluvium, one of hree of clay, and three of conglomerate, amounting to fourteen feet of deposits above the bones. Professor ates that this whole list of strata is a pure fiction. The n was found close to the surface, with nothing but the muck over it. The men who assisted at the exhuma- lso informed Dr. Hoy that Dr. Koch did not drain the s might have been done without great difficulty, but that they simply dug out the muck and earth, often work-) to their waists in the water, and groping with their at the bottom to find the bones. In these circumstances bvious, aside from the question of veracity, that no ac- determination could have been made between flint ns of later date and those which might be contempora- with the animal.

re seems no *à priori* improbability in the idea that the lon may have survived until after the advent of man his continent, but it is evident that Dr. Koch's testimony utes nothing to the solution of that question.

following fact may throw light on the burnt skeleton in ıade County, without impeaching Dr. Koch's testimony the scorched condition of those bones. The Western are much more subject to long droughts than the Atlan- tes or European countries. Here it is a common thing, y dry seasons, for a peat-bed to be accidentally set on ıd completely burned up. In these cases all the bones re scorched, trees growing on it are undermined, and fall nd any stone implements, or other incombustible objects n the surface sink down among the more ancient relics Afterward, the peat grows again, covering them all r sometimes the freshets of neighboring streams fill the with clay and other river detritus. The skeleton in ıade County may have been scorched in this way, and

stones and arrowheads of a later age mingled with the bones. In examining the relics found in western swamps, it is always necessary to guard against the possibility of error introduced by the action of fires of this character.

No. 6, 16th street, Chicago.

ART. IX.—*Rate of Growth of Corals.* From a letter to Professor J. D. DANA, by Professor JOSEPH LECONTE, dated University of California, May 1, 1875.

I OBSERVE in your work on Corals and Coral Reefs, while discussing the rate of coral growth, you mention an interesting observation of Weinland on the corals about Hayti, bearing on this subject. This recalls to my mind a very similar observation on a much larger scale, made by myself during the winter of 1851, while assisting Professor Agassiz in his examination of the Florida reefs. Knowing your interest in the subject, I send you an account of it.

Professor Agassiz and his party were at Fort Jefferson, Tortugas. Dr. Wm. L. Jones and myself had gone to examine a little island about 8 or 10 miles to the northwest. On returning to Fort Jefferson in a small boat, when about half way between the two islands and in the still shoal water on the inside of the line of reefs, to our great surprise the boat suddenly grounded on the close-set prongs of an extensive grove of madrepores (*Madrepora cervicornis?*). On examining closely the trees of this grove, we found: 1. That the prongs were far more thickly set than is usual in this species; 2. that all the prongs not only of the same tree, but of all the trees of the whole grove, grow up to nearly the same level, which at the time examined was very near the surface; 3. that all the prongs at that level were dead for a distance of one to three inches from the point. The lower limit of death seemed to be a *perfectly horizontal plane.* The dead points rose above it to various distances not exceeding three inches. We rowed around the margin of this grove for a considerable distance and found everywhere the same phenomena. I satisfied myself that the whole grove, for hundreds of acres in extent, had been clipped in a similar manner.

On subsequent inquiry at Key West, I learned that the mean level of the ocean, owing probably to the prevalence of certain winds, was higher during one portion of the year than during the other. It became evident, therefore, that during the high water the living points of the madrepores grow upward until the descending water level exposes and kills them down to a

certain level. With the rise of the mean level again, new points start upward, to be again clipped at the same level by the descending water. The levelness, the thick setting, and the deadness of the points are all thus completely accounted for. It is precisely the phenomena of a clipped hedge.

I have long been accustomed to estimate from these facts the rate of madrepore growth. I have recently looked up the data necessary to do so more accurately.

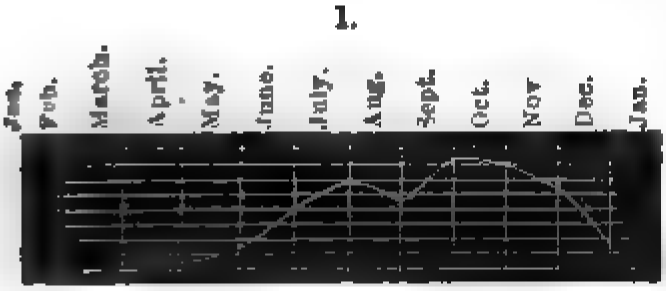
The following table, taken from the Coast Survey Report for 1853, p. 76, gives the mean sea level for the different months of the year.

	Feet.	Dif.		Feet.	Dif.
Jan.	5·10	0	July	·78	·68
Feb.	·15	5	Aug.	·63	·53
March	·26	·16	Sept.	·93	·83
April	·26	·16	Oct.	·90	·80
May	·32	·22	Nov.	·73	·63
June	·60	·50	Dec.	·31	·21

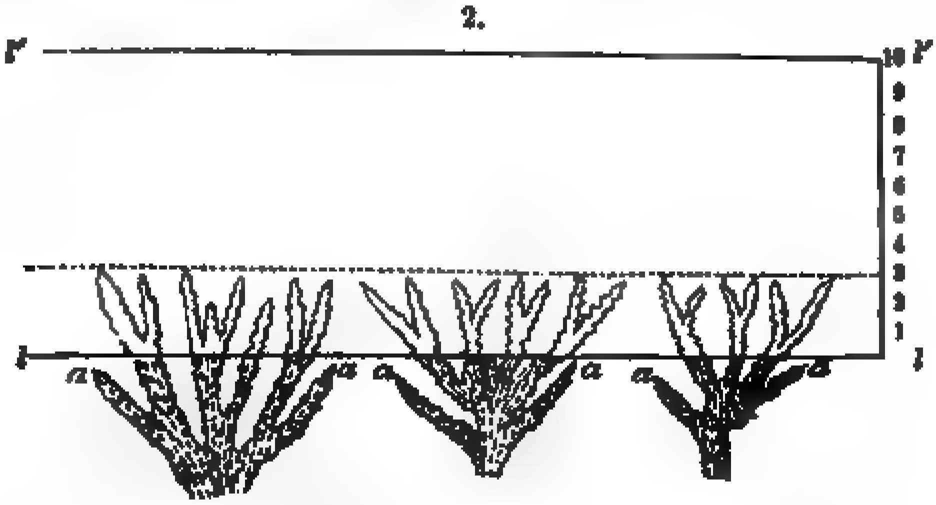
From the differences I have roughly plotted a curve representing the annual variation of mean level.

It is seen that the mean level at Key West is lowest in January and highest in September, the difference being 0 83 feet or about ten inches. Now starting with the lowest mean level in January, *l l*, it is evident that living points *a a a* near that surface would grow upward and continue to grow all the time the water was rising from *l l* to *l′ l′*, i. e., from middle of January to the middle of September, and also while it was falling to three inches above *l l*, i. e., until about the beginning of December. At this level

1.



2.



the growing points would be nipped. It is evident, therefore, that the three inches were grown in 10 to 10½ months, which would make about 3½ *inches per annum*.

This table is taken from Key West; my observations were at the Tortugas. There may be differences in the amount and the curve of variation in different places. But this would make but little difference in the result. I believe we may say with confidence that the annual growth of madrepore points in the Gulf is not more than 3½–4 inches per annum.

ART. X.—*Brief Contributions to Zoology from the Museum of Yale College.* No. XXXIII.—*Results of Dredging Expeditions off the New England Coast in* 1874; by A. E. VERRILL.

IN the last number of this Journal a general statement was made of the operations in connection with the U. S. Fish Commission, located during the summer of 1874 at Noank, Connecticut, on Fisher's Island Sound, and close to the eastern end of Long Island Sound.

In the following article only a brief summary of the results can be given; the full details will eventually appear, however, in the report of the Commissioner.

The total number of recorded stations, where dredgings were made during the summer, is 180, but many others, not registered, were made by members of the party. A large number of additional localities along the shores and in the shallow waters of the harbors were explored by hand nets and otherwise with excellent results. Temperatures were not taken at all the dredging localities, and therefore, in the accompanying table, such localities have been, for the most part, omitted.

The localities dredged may be conveniently grouped as follows:

a. Fisher's Island Sound, mostly hard gravelly and stony bottoms, often rocky, and occasionally with some sand or mud, the depth varying from 4 to 15 fathoms. The tidal currents were rather strong and the bottom temperatures were low (usually 61° to 65° F.).

b. Block Island Sound, including a wide region from off Point Judith, R. I., to Race Point, at the western end of Fisher's Island; the depth varying from 5 fathoms or less to upwards of 40 fathoms, near Race Point (No. 45). The currents are strong, especially toward Race Point, and the temperatures are low (56° to 64°). The bottom is generally gravelly, stony, or sandy, occasionally rocky, and but seldom muddy. An extensive "scollop-bank" (*Pecten tenuicostatus*) occurred in 18 to 22 fathoms, south of Watch Hill, where many interesting species were found, among which was *Leptasterias compta.**

* This species, when living, is of a beautiful violet color (rarely brownish). Occasionally there are six rays. It is a delicate and rather fragile species, the

c Off Block Island and south of Montauk Point, L. I., including various fishing banks or "ledges," among which is Coxe's Ledge, about 18 to 20 miles east-southeast from Block Island. Among these localities there are both hard gravelly and muddy bottoms, and some that are sandy. The greatest depths were 32 to 34 fathoms, muddy, about 10 miles southeast from Block Island (Nos. 161, 162); and 25 fathoms, sandy, about 11 miles southeast from Montauk Point (No. 116). Throughout this region the bottom temperatures were found to be low (45½° to 57°), and the fauna correspondingly arctic.

d. The eastern part of Long Island Sound, from Fisher's Island and Gardiner's Island to the mouth of the Connecticut River, the depths varying from 3 or 4 to 50 fathoms, the deepest water occurring a few miles west of Race Point (see Nos. 35, 36, 45, 46), where the tidal currents are very strong and the bottom rocky. The bottoms are variable, but mostly stony or gravelly, and not unfrequently more or less muddy, while the temperature in all the deeper localities was low (58° to 62°) and the fauna arctic.

e. Shallow water localities in the harbors and estuaries near Noank, Stonington, etc. The bottoms are generally muddy and mostly thickly covered with eel-grass (*Zostera marina*).

f. Gardiner's Bay, Long Island. The localities were mostly sandy; the depths 3 to 10 fathoms; and the bottom temperatures were higher (64° to 68°) and the fauna more southern than in the more open sounds.

g. Great Peconic and Little Peconic Bays, and Greenport Harbor, L. I. In these localities the temperatures were much higher (71° to 72½°) than those of the other localities examined, and the fauna was very decidedly southern, including some species not before observed north of Florida and South Carolina. In Little Peconic Bay the bottoms were mostly sandy and shelly (mainly *Crepidula fornicata*, both dead and living), and the depths were 4 to 13 fathoms. In Great Peconic Bay the water was shallow, 4 to 6 fathoms, and the bottoms muddy and rather barren in all the localities examined.

As the faunæ of the various kinds of bottoms and shores, both of the bays and harbors and of the outer cold waters, have been fully described, and most of the species enumerated by me, in a recent work,* it will not be necessary to give, at this time, more than a summary of those species not included in

rays easily becoming detached. Hundreds of specimens of this hitherto rare species were obtained at this locality. At this place two fishes (a species of *Liparis* and a young hake, *Phycis*) were often found in the gill-cavity of the Pectens with *Pinnotheres maculata*.

* Report on the Marine Invertebrates of Southern New England; Appendix of 1st Report of the U. S. Commissioner of Fish and Fisheries, 1874; also a separate edition.

that report, and now for the first time recorded from the southern coast of New England.

It may, however, be well to state that the fauna of the localities included under the groups *a*, *b*, *c* and *d*, is nearly identical with, though a little more arctic than, that of the outer waters off Martha's Vineyard and Cuttyhunk Island, described in the report referred to: while that of the localities under *e*, *f* and *g*, is essentially the same as that of Vineyard Sound and the estuaries and harbors connected with it, as described in the same work, though the fauna of the Peconic Bays is a little more southern than that of Vineyard Sound or Wood's Hole.

List of species new to the fauna of Southern New England.

In this list I have included, also, a few species added to the fauna during excursions from New Haven, by myself and others, though not obtained during the explorations by the Fish Commission. A few species, marked (*), not new to the fauna, have also been introduced in order to confirm the localities, or to correct the nomenclature. But numerous species, especially of Crustacea and Sponges, added to the fauna last summer, are here omitted, because not yet sufficiently studied. Many of them are undescribed.

Arachnida.

Pycnogonum littorale Müller = *P. pelagicum* Stimpson. West of Race Point, 50 fathoms (Nos. 35, 36).

Thalassarachna Verrillii Packard. Low water and just below, and in pools, among eel-grass, ascidians, hydroids, etc.

Crustacea.

The Crustacea have been identified by Mr. S. I. Smith.

**Hyas coarctatus* Leach. Coxe's Ledge, 21 fathoms; Block I. Sd. (Nos. 85–90).

Dexamine Thea? Boeck. Noank Harbor, among eel-grass.

Melita dentata Boeck. Off Fisher's Island, 9 fathoms; off Watch Hill, 18 fathoms; off Race Pt., 42 fathoms.

Melita, sp. nov. East-southeast 10 miles from Block Island, 32 fathoms, muddy; off Isles of Shoals, N. H., 35 fathoms.

**Ampelisca macrocephala* Lilj. = *Ampelisca*, sp., Smith in Report on Invert., p. 561, pl. IV, fig. 17. Off Buzzard's Bay, 29 fathoms, 1871.

A. typica Boeck. Fisher's I. Sd., 17 fathoms; Block I. Sd., 17 to 19 fathoms (Nos. 74, 75); off Saybrook, Conn.; Noank, among eel-grass.

A. limicola Bate (Stimpson sp.). Noank Harbor, among eel-grass and mud, common; Fisher's I. Sd., 3 to 6 fathoms, sandy.

Ampelisca, sp. nov. Fisher's I. Sd., 7 to 9 fathoms; Block I. Sd., 17 to 19 fathoms (Nos. 74, 75); off Martha's Vineyard, 23 fathoms, 1871.

Xenoclea megachir Smith. Trans. Conn. Acad., 1874. Off Watch Hill, 18 fathoms.

**Hyperia medusarum*. Off New Haven; Noank; Vineyard Sound, and northward, on *Cyanea* and other jelly-fishes.

H. spinipes Boeck. Vineyard Sound.

Several other species of Amphipods, not yet determined, were obtained.

Anilocra, sp. New Haven, in mouth of *Loligo* (Clark).

Tanais vittatus Lilj. Noank Harbor, on piles at low water, and among eel-grass.

Other species of Isopods occurred, among them a curious new species allied to *Paranthura*, from off Watch Hill, 18 fathoms.

Argulus, sp. On *Fundulus pisculentus*, Noank, etc.

Several undetermined species of Lernæans occurred on the sturgeon, drum-fish (one in the gill-cavity and another on the skin and fins), orange file-fish, skate, etc.

Balanus porcatus Costa. Off Watch Hill, 18 fathoms; Long. I. Sd., 24 to 50 fathoms, off Race Point, (Nos. 35, 36, 47).

Annelida.

lais, sp. nov. Various localities in Block I. Sd.; Fisher's I. Sd.; and Sound, 10 to 40 fathoms, on sandy bottoms.
minuta Malmgren. Block I. Sound, 17–21 fathoms, mud.
lys cæca Malmgren. Off Stonington, 4–5 fathoms, Aug. 16.
doce Grœnlandica Œrsted. Fisher's Island Sound, 12–14 fathoms.
ea gracilis Verrill. Noank Harbor.
is lucifera Verrill, sp. nov.* Noank, on piles, and eel-grass, July 11–31.
pallida Verrill, sp. nov.† Plate III, fig. 6. Noank Harbor, Aug. 15–17.
sp. A yellowish white species, with broad obtuse palpi, and moniliform and cirri; Block Island Sound, 17–21 fathoms, Aug. 21.
riconereis obtusa Verrill. Noank Harbor, 1–1½ fathoms, mud and dead eel-ly 8.
ta Verrill, sp. nov.‡ Off Block Island, 14 fathoms, Aug. 19.
ia denticulata Verrill, sp. nov.§ Off Block Island, 14 fathoms, Aug. 19.
cola marina Malmgren. In sand at low-water on a beach about 3 miles Noank, July 9.
onia aspera Stimpson.
, sp. Block I. Sound, 17–24 fathoms.
ora, sp. Burrowing in dead shells of *Pecten tenuicostatus*; off Block Block I. Sound, 18–21 fathoms.
ora, sp. Noank Harbor, 1–1½ fathoms, mud and dead eel-grass.
lla, sp. Off Sea-flower Reef, 6–9 fathoms, sand.
tria capillaris Verrill. Off Block Island, 15–20 fathoms, mud.
ides granulata Malmgren. Long I. Sound, off Race Point, 50 fathoms.
rus cincinnatus Malmgren. Coxe's Ledge, 20 fathoms, sand and gravel.
irrus, sp. A bright red species, with brilliant blue phosphorescence. Off Hill, 18–22 fathoms; Coxe's Ledge, 20 fathoms; Bay of Fundy, low-water thoms.

yllis lucifera Verrill, sp. nov.
rather slender, about 18mm. long; head broader than long, emarginate wider and broadly rounded in front, eyes rather large, the anterior pair a ider apart than the posterior; palpi broad and short, about one-third as the head, blunt or obtusely rounded in front; antennæ stout, tapering, the considerably longer and larger than the lateral, about equal to twice the of the head; tentacular cirri, like the antennæ and dorsal cirri, trans-wrinkled, the upper ones about equal to the median antennæ, the lower little smaller; dorsal cirri of the first segment longer than the antennæ, th exceeding three times the breadth of the head; cirri of the two follow-nents less than half as long; those on the fourth longer and on succeeding s generally alternately longer and shorter, but mostly less than half the r of the body. Color yellowish white, with a dark intestinal line. Phos-ent with a bright green light.
is pallida Verrill, sp. nov. Plate III, figure 6.
slender, tapering to both ends, about 15mm. long and ·5 to ·75mm. broad. mall, length about equal to breadth, rounded behind, produced in front, light antero-lateral angle on each side; palpi large, elongated, lanceolate, at tips; eyes small, the anterior very wide apart. Antennæ and cirri short, distinctly annulated or moniliform; the median antenna largest; irri variable in length, or alternately longer and shorter. The longer ones ne half longer than the breadth of the body, composed of 17 or 18 annula-Color white, with a yellowish intestinal line posteriorly. None of the ve setiform tips.
nbriconereis acuta Verrill, sp. nov. Plate III, fig. 5.
is a slender species, easily distinguished by its very long acute head, s about three times as long as broad. The lateral appendages are short, short obtuse upper lobe.
helia denticulata Verrill, sp. nov.
long and round; 9 anterior segments with short setæ; 18 with slender branchiæ, denticulate on the front edge; 5 caudal segments with long nal segment with 16 to 18 slender acute papillæ, and two larger lanceolate low. Length, 70mm.; diameter, 6mm.

Pista cristata Malmgren. Long Island Sound, off New London, 8 fathoms, m and sand (loc. 17), July 17.

Chone, sp. North of Block I., 18–24 fathoms, mud and sand, Aug. 6; Cox Ledge, 21 fathoms.

Filigrana implexa Berkeley. Fisher's I. Sound; Coxe's Ledge, 21 fathoms.

Spirorbis nautiloides (?) Lamarck. Fisher's I. Sound; Coxe's Ledge, 21 fatho

Spirorbis, sp. Shell bicarinated. With last.

Bdellodea, Gephyrea, etc.

Ichthyobdella, sp. Parasitic on sculpin (*Cottus*, sp.), Thimble Islands, M 1874. Whitish, with reddish intestinal lines.

Chætoderma nitidulum Loven. Off Block I., 32–34 fathoms, mud (loc. 161, 16

Tristoma læve Verrill,* sp. nov. Block I., in mouth of bill-fish.

T. cornutum Verrill.† Block I., on gills of bill-fish (*Tetrapturus albidus*).

Nitzschia elegans Baer. On gills of sturgeon (*Acipenser oxyrhynchus* Mitchel)

Turbellaria.

Lineus viridis V. = *Nemertes viridis* Verrill, Rep. on Invert., p. 628. Noa low water and 1 fathom, mud.

Tetrastemma dorsalis McIntosh. Noank harbor, on eel-grass and in 1–1½ fa oms, mud, July 8; Casco Bay.

T. elegans Verrill (= *Hecate elegans* Girard). Fisher's Island Sound.

Body about 14mm. long, slender, depressed, tapering to tail; head wider th neck, obtuse or emarginate; eyes conspicuous, nearly in a square, the anter ones a little nearer together than the posterior. Color of body light yellow, w a broad band of deep brown on each side, leaving a wide dorsal stripe. A p yellow variety (?), from Noank harbor, has the lateral bands rather ill-defir consisting of more or less separated specks.

T. candida (?) Œrsted. Noank harbor, 1–1½ fathoms, mud; Casco Bay.

Amphiporus bioculatus McIntosh. Noank harbor, 1–1½ fathoms, mud, July Fisher's I. Sd., 7 fathoms, mud and sand.

A. hastatus McIntosh (?). Block I. Sd., 18–45 fathoms, Aug. 6.

Cephalothrix linearis Œrsted. Noank harbor, 1–1½ fathoms, mud and eel-gra Casco Bay, low water.

Gastropoda and *Lamellibranchiata.*

**Scalaria Grœnlandica*. Block Island Sound, 17–24 fathoms, Aug. 6.

Velutina lævigata. Off Watch Hill, 18–20 fathoms.

* *Stylifer Stimpsonii* Verrill. Block I. Sound (Nos. 85–90), 6–15 fathoms.

* *Tonicella marmorea* Carpenter. (*Chiton marmoreus* Gould.) Off Block Isla

Philine quadrata. Off Montauk Point, 20–25 fathoms, sand (Nos. 115, 116).

Montagua Bostoniensis (Cauthouy, sp.). South of Fisher's Island, 32 fatho Aug. 11 (No. 91); off Montauk Point, Aug. 13 (No. 14).

Embletonia fuscata Gould; also var. *remigata* and var. *lanceolata* (Gould). Occ of all shades of color, from pale flesh-color to dusky brown. Piles at Noa common on hydroids.

* *Tristoma læve* Verrill, sp. nov.

Length about 15mm., very thin, and broad elliptical; anterior end somew produced and broadly rounded; posterior end emarginate; dorsal surface smoo lower with minute granule-like papillae. Color white, translucent. Poster sucker large, about a third of the breadth of the body, campanulate, the cen area large, with seven angles, from which seven lines radiate; the edge is divi into very numerous denticles; anterior suckers also large, about one-half broad as the posterior, separated by a space less than their diameter.

† *Tristoma cornutum* Verrill, sp. nov.

Body thin, broad elliptical, or oblong, emarginate posteriorly; anterior e narrowed, produced, and with a short, tapering, tentacle-like process at e angle; upper surface with minute rounded granules and small scale-like wrinkl smooth beneath. Posterior sucker small, less than one-fourth the breadth of body, its border divided into much fewer and larger teeth than in the preced species; anterior suckers two-thirds as broad as the posterior, nearly two dia eters apart. Color light red or flesh-color.

Doto formosa Verrill, sp. nov.* Off Point Judith, 10–14 fathoms, Aug. 19.

Idalia modesta Verrill, sp. nov.† Off west end of Fisher's Island, Aug. 25, 1874, on sandy and muddy bottom; Block Island Sound, 17–24 fathoms, Aug. 6; north of Little Gull Island, 40 fathoms (No. 19).

Entalis striolata Stimpson. Off Block Island, 20–25 fathoms (115, 116).

Thracia myopsis. West of Fisher's Island, 7–9 fathoms, Aug. 25.

Tunicata.

Amaroecium glabrum Verrill. Off Block Island.

Bryozoa.

**Discoporella verrucaria* Smitt=*Diastopora patina* Verrill, in Report on Invert. S. N. E., 1873. Fisher's Island Sound.

**Tubulipora serpens* (irregular variety)=*T. flabellaris* Verrill, in Report on Inv.

Alcyonidium, sp. A smooth red species, incrusting shells. Off Watch Hill, 18-22 fathoms, on shells of *Pecten;* Casco Bay; Bay of Fundy.

Bicellaria ciliata Blainville. Fisher's I. Sound, 8–12 fathoms; Bay of Fundy, 10 to 30 fathoms; off Gay Head, 19 fathoms.

**Biflustra tenuis* V.=*Membranipora tenuis* Desor; Verrill, in Report on Invert., p. 712. Low-water to 40 fathoms.

Membranipora unicornis Flem., and *var. Americana* (D'Orb.). New Haven, on algæ, etc.; Fisher's I. Sound; Block I. Sound; Casco Bay; Bay of Fundy, etc.

**Cribrilina puncturata* Smitt. Plate III, fig. 2,=*Escharipora punctata* V., in Rep. on Invert., p. 713. New Haven, Noank, etc.

Porina ciliata Smitt. New Haven, on red algæ; Thimble Islands; Fisher's I. Sound; Vineyard Sound, 5–8 fathoms, on shells of *Mactra*.

Escharella pertusa ?.‡ Fisher's I. Sound; Block I. Sound; eastern end of Long I. Sound, 8–40 fathoms; Bay of Fundy.

Hippothoa biaperta Smitt.§ New Haven, on red algæ; Thimble Islands, in pools; off Watch Hill, 3–5 fathoms; Vineyard Sound, abundant.

H. reversa V., sp. nov.‖ Off Gay Head.

Eschara verrucosa, var. propinqua Smitt. Off Buzzard's Bay, 25 fathoms; Nantucket Shoals, abundant; Bay of Fundy, etc.

* *Doto formosa* Verrill, sp. nov. Plate III, fig. 4.
Dorsal papillæ about 8 on each side, stout, ovate, narrowed at base, covered with numerous short, obtuse or rounded, small, white-tipped papillæ. Tentacles slender, the sheaths funnel-shaped, obliquely truncated, with slight emarginations in front and on the outer side. Body translucent white; tentacle-sheaths and dorsal papillæ covered with flake-white specks. Length about ·5 of an inch.

† *Idalia modesta* Verrill, sp. nov. Plate III, fig. 3.
Body oval, very convex. Tentacles long, about equal to breadth of body, slightly serrate or wrinkled; obtuse; cirri at their bases about half as long, very slender, with acute white tips. Branchiæ about 12, rather long, pinnate; two slender cirri close together, behind the bases of the gills on each side; four much smaller conical papillæ in a row on each side. Color of back and branchiæ deep orange-brown, mottled with yellowish and greenish white. Length about ·5 of an inch.

‡ This species has large zoœcia, with numerous coarse pores; oœcia large, subglobular, roughened with prominent granules, and perforated by small pores; apertures with a broad shallow sinus, and small lateral denticles within; avicularia lateral, rarely present, opposite the side of the aperture, broad, obtusely rounded, the point directed toward the aperture.

§ To the genus *Hippothoa*, as limited by Smitt in his recent work on Florida Bryozoa, belong *Escharella variablis* and *Mollia hyalina* of my Report on Invert. of Southern New England. The former is very nearly allied to, if not identical with *H. Isabelleana* of Smitt, Florida Bryozoa, p. 44, plate VIII, figs. 166–168, 1873.

‖ *Hippothoa reversa* Verrill, sp., nov. Plate III, fig. 1. Zoœcia oblong, the front perforated with scattered pores of moderate size; apertures rounded, with a shallow rounded sinus; a small mucro is often present in front of the aperture; avicularia narrow, elongated, acute, somewhat curved, raised above the level of the zoœcia, the point most raised, and directed outward and backward.

Cellepora avicularis Hincks. Off New Haven; Fisher's I. Sound; St. George' Bank; Bay of Fundy, etc. Common on *Sertularia*.

**Lepralia Americana* Verrill. This Journal, vol. ix, p. 415, plate VII, figs. 4, 5, =*L. Pallasiana?* Verrill, Report on Invert., p. 713, 1873. New Haven Harbor; Noank, on eel-grass, etc.; Vineyard Sound; Beverly, Mass.; Long I. Sound, low-water to 40 fathoms (loc. 29), on shells, stones, etc., with oœcia.

Discopora nitida Verrill. This Journal, ix, p. 415, pl. VII, fig. 3, June, 1875. Thimble Islands, on algæ in pool at low-water; Fisher's I. Sound, 3 to 12 fathoms; Vineyard Sound, 5 to 10 fathoms, common on shells.

Echinodermata.

Lophothuria Fabricii Verrill. Off Block Island, 20–21 fathoms (157–9).

Acalephæ.

Bolina alata Agassiz. Newport, R. I. (A. Agassiz).

Campanularia verticillata Lamarck. Block I. Sd., 17–45 fathoms; Fisher's I. Sd., 4–11 fathoms.

C. calceolifera Hincks. Plate IV, fig. 6. Noank, on bottom of scow; Wood's Hole, on piles, 1871.

Clytia noliformis (McCready). Plate IV, fig. 2. New Haven, Sept., 1874.

Gonothyræa hyalina Hincks. Off Watch Hill, R. I., 18 fathoms, July 31.

G. Loveni Allman. Noank, on piles of wharf.

G. gracilis Allman. Fisher's I. Sd., 4–13 fathoms; off Watch Hill, 18 fathoms; off Montauk Pt., 6–20 fathoms.

G. tenuis Clark, sp. nov.* New Haven, on piles of Long Wharf, June, 1875 (Clark).

Obelia bidentata Clark, sp. nov.† Greenport, L. I., on piles, Aug. 5.

O. bicuspidata Clark, sp. nov.‡ Off Thimble Islands, 4–5 fathoms, rocks, Sept., 1874.

Opercularella lacerata Hincks. New Haven, on piles, May, 1875 (Clark).

O. pumila Clark, sp. nov.§ Portland, Me., on piles; off Montauk Pt., 5–15 fathoms.

Halecium articulosum Clark, sp. nov.‖ Long I. Sound, 8–12 fathoms; Coxe's Ledge, 17–21 fathoms; Casco Bay; Bay of Fundy.

* *Gonothyræa tenuis* Clark, sp. nov. Closely allied to *G. Loveni*, but has narrow, elongated, obconic gonothecæ, tapering gradually to the base.

† *Obelia bidentata* Clark, sp. nov. Plate IV, fig. 10.
Stems clustered, compound, nearly straight, thickly branched; mode of branching irregular, a few of the lower branches sometimes attaining a considerable length and resembling the main stem; branchlets and ends of the branches simple, slender, translucent and very graceful. Hydrothecæ very deeply campanulate with 9–12 longitudial lines, and the rim ornamented with very acutely bidentate teeth.

‡ *Obelia bicuspidata* Clark, sp. nov. Plate IV, fig. 11.
Stem erect, slender, compound, sparingly branched; branches short, slender, ascending and irregularly arranged. Hydrothecæ very deeply campanulate, narrow, very hyaline, and with 8–10 longitudinal lines extending from the distal extremity nearly to the base. The rim is armed with acutely bidentate teeth.

§ *Opercularella pumila* Clark, sp. nov. Plate IV, figs. 7, 8, 9.
Stem rather stout, erect or creeping, slightly flexuous, sparingly branched. Hydrothecæ largest in the middle, tapering very slightly toward the base and rapidly converging toward the distal end; operculum composed of a few convergent segments, not very deep. Gonothecæ fusiform, about twice the length of the hydrothecæ.

‖ *Halecium articulosum* Clark, sp. nov.
Stem stout, compound, sparingly branched, dark brown or black; branches short and irregularly arranged on all sides of the stem; branchlets few and very short; branches and branchlets divided into short, stout internodes by distinct joints placed at right angles to the stem. Hydrothecæ short and wide. Gonothecæ sessile, borne in rows on the upper side of the pinnæ. The female are obovate, and have the opening on one side, nearer the distal end. The male gonothecæ are oblong, subcylindrical.

ım halecinum Johnst. Off Saybrook, 14–23 fathoms; Block I. Sound, .thoms; Fisher's I. Sound, 4–11 fathoms.
mii Johnston. Off Saybrook, 6–23 fathoms; Fisher's I. Sd., 7–11 fath-ock I. Sd., 17–21 fathoms. Casco Bay; Bay of Fundy.
ı cornuta Lamx., 1812 = *L. dumosa* Sars (Flem. sp.). Nantucket Shoals.
della costata (?) Hincks. Fisher's I. Sd., 9–11 fathoms.
ılla syringa Hincks. Plate IV, figs. 3, 4, 5. Fisher's I. Sd., 4–14 fathoms, calities; Block I. Sd.. 17–45 fathoms; off Saybrook, 6–8 fathoms.
ır. pygmæa (Hincks). Fisher's I. Sd., 5½–6½ fathoms.
arella polyzonias Gray, *var. gigantea* Hincks = *Cotulina tamarisca* A. Ag., cal. N. A. Off New London, 6 fathoms; Gardiner's Bay, 6–8 fathoms; Sound, 17–24 fathoms.
ıosa Gray. Noank, on piles of wharf; off Watch Hill, 17–21 fathoms.
ısia fallax Agassiz. Off Watch Hill, 17–21 fathoms.
ıacea Agassiz. Fisher's I. Sound, 9–11 fathoms, July 14, with gonothecæ.
aria gracilis Hincks. Hyannis, Mass., on *Sargassum.*
ıatodes Floridianus Agassiz. Greenport Harbor, L. I., Aug. 5; Florida.
ophora laciniata Agassiz. Fisher's I. Sound, July.
.itis Agassizii McCr. Greenport Harbor, Aug. 5; Charleston, S. C.
ıocnida spectabilis Agassiz. Noank Harbor, on bottom of vessel.
ıria indivisa Linn. Off Saybrook, 4–9–22 fathoms; Fisher's I. Sound, homs; Block I. Sound, 17–24 fathoms; off Block Island, 14 fathoms.

Anthozoa.

ıthus borealis Verrill, (young specimen). Off Watch Hill, R. I., 18 fathoms,

ıa crassicornis Ehrenberg. Fisher's I. Sound, 12–14 fathoms; Block I. 5–8 fathoms (Nos. 85–90); off Watch Hill, 18 fathoms.

eral sponges, new to the fauna, were also obtained and studied by Prof. Hyatt. Among them is a curious very r and delicate, bipinnately branched species from the ɔoth at Greenport and Noank. Numerous ciliated Proto-ːre also observed, but are mostly not accurately identified. g them is the curious *Freia ampulla*, on eel-grass, and n *Sertularia* from 50 fathoms. Some of the Rhizopods tudied by Dr. E. Bessels, and others by Dr. Joseph Leidy.

EXPLANATION OF PLATES.

I.—Figure 1. *Hippothoa reversa* V., enlarged 32 diameters.
Figure 2. *Cribrilina puncturata* Smitt. Off Noank.
Figure 3. *Idalia modesta* V., enlarged about 6 diameters.
Figure 4. *Doto formosa* V., enlarged about 10 diameters.
Figure 5. *Lumbriconereis acuta* V., much enlarged.
Figure 6. *Syllis pallida* V., much enlarged.
es 1, 2, 3, were drawn by the author; 4, by J. H. Emerton; 5 and 6, by lake.

'.—Figure 1. *Clytia Johnstoni*, enlarged 16 diameters.
Figure 2. *C. noliformis* V.. 16 diameters.
Figure 3. *Calycella syringa*, 32 diameters.
Figures 4, 5. The same, showing peculiar variations.
Figure 6. *Campanularia calceolifera*, 16 diameters.
Figure 7. *Opercularella pumila* Clark, from Portland, Me.
Figure 8. The same, creeping form.
Figure 9. The same, young stems from off Montauk Point.
Figure 10. *Obelia bidentata* Clark, 16 diameters.
Figure 11. *O. bicuspidata* Clark, 16 diameters.
e 2 was drawn by the author; the rest by Mr. S. F. Clark; all with lucida.

[To be continued.]

ART. XI.—*Examination of Gases from the Meteorite of Feb. 12, 1875*; by ARTHUR W. WRIGHT.

THIS meteorite fell, on the date above mentioned, in Iowa County, in the State of Iowa. By the agency of Professor N. R. Leonard, of the Iowa State University, a large amount of the meteoric mass was collected, and from him, by the courtesy of President Thacher of the same institution, a number of fragments were received by the writer, for an examination, of which a brief notice was published in the preceding number of this Journal. A description of the meteorite, and of the circumstances which attended its fall, by Prof. Leonard, will be given in the next number of the Journal.

The meteorite is of the stony kind, not greatly differing in its general appearance from others of the same class. Numerous small grains of metallic iron and of the magnetic sulphide of iron, or troilite, are scattered through the mass, the iron grains ranging in size from the finest particles, like mere powder, to those of the size of a fig-seed, with occasionally one as large as a grape-seed.

Among the fragments received, there are some which show distinct evidences of a sort of lamination or imperfect stratification, the portions at which the surfaces separated being smoothed down, as if by pressure or friction. Several minute veins are visible, which appear to be filled with material of somewhat different constitution. Their relation to the general mass cannot be distinctly made out, and it is doubtful whether they indicate anything more than that cracks formed in the mass while cooling, and that the fissures thus formed were filled up again, perhaps by the still fluid, matter from the interior. They seem to indicate that the mass of which the meteorite probably once formed a part was of great size.

The recent investigations of Prof. Newton, Schiaparelli, Oppolzer, and others, in respect to some of the great meteoric streams, have resulted, on the one hand, in establishing the identity of their orbits with those of certain well-known comets, and on the other, in showing that the bodies belonging to these streams are probably of the same nature as the sporadic or occasional meteorites. It seemed probable, therefore, that an examination of the gases yielded by a freshly fallen meteorite would be likely to furnish important information respecting the tails of comets, and these anticipations were found to be not unwarranted by the results.

The examination was made in the manner described in a previous article,* and with the same apparatus. The first trial,

* This Journal, III, ix, Apr., 1875, p. 294.

which was made with a quantity of the iron extracted from the meteoric mass, showed that the gaseous contents differed in a marked degree from those obtained from iron meteorites hitherto examined, inasmuch as they contained a very large percentage of carbon di-oxide, with a smaller proportion of carbonic oxide, and a large residue of hydrogen, the two oxides of carbon making about one half of the gaseous mixture. The percentages obtained in the preliminary trial were, CO_2, 35; CO, 14; or 49 per cent of carbon compounds, the hydrogen not having been estimated. This was merely a rude approximation, and the amount of CO is overstated, at the expense of the CO_2. These results were obtained with the particles of iron separated from the powdered stone with a magnet. The residue, however, contained a considerable amount of iron in particles too small to enable them to lift the bits of the stony matrix in which they were enclosed. As this was found to introduce irregularities in the determinations, the portions of meteorite employed in the experiments to be described were finely pulverized in a diamond mortar, and the whole immediately placed in the glass tube to be attached to the Sprengel pump, the iron not being separated from the rest. Larger volumes of the gases were extracted than in the first trial, and the relative proportions of the different constituents carefully determined by analysis.

Powder formed from about four cubic centimeters of the solid meteorite was placed in the tube upon the pump, and the air very thoroughly exhausted. It was soon found that the relative amounts of the different constituents driven off by heating the tube varied with the temperature, and the experiments were so conducted that the portions separated at different temperatures could be examined separately.

On applying the heat of the hand to the tube for a short time, a small amount of gas was liberated, too small for anything more than a rude qualitative test as to its composition, which showed the presence of carbon di-oxide and some hydrogen. The tube and its contents were then brought to the temperature of boiling water by surrounding it with a wider glass tube, through which steam was passed for several hours. Gas was given off in considerable quantity, and enough was collected for an analysis. This was found to contain 95·46 per cent of carbon dioxide, and 4·54 per cent of hydrogen, the carbonic oxide, if present, being in too small amount for estimation with certainty. A moderate heat was now applied for a short time with a small Bunsen flame, raising the temperature to 200° or 250°. This separated a still greater quantity of the gases, in the following proportions: CO_2, 92·32; CO, 1·82; H, 5·86. A stronger heat was then applied for nearly an hour, the tempera-

ture, however, being kept below that of redness. About three cubic centimeters of gas were given off, which was found to consist of CO_2, 42·27; CO, 5·11; H, 48·06; N. 4·56. The tube with its contents was now brought to a low red heat, which was maintained for half an hour or so, the effect being to liberate nearly the same volume of gas as before, containing CO_2, 35·82; CO, 0·49: H, 58·51; N, 5·18. Finally it was brought to a full red heat, which caused the evolution of much more gas, yielding, on analysis, CO_2, 5·56; CO, 0·00; H, 87·53; N, 6·91. The whole amount of gas given off was about two and one half times the volume of the solid portion of the meteorite employed; but this was not the whole, for the heat was discontinued before its evolution had entirely ceased. If referred to the iron alone, it would be about twenty times its volume.

The following table gives a comparative view of the relative proportions of the gases obtained at different temperatures, the nitrogen being determined as a residue:

	At 100°.	At 250°.	Below red heat.	At low red heat.	At full red heat.
CO_2	95·46	92·32	42·27	35·82	5·56
CO	0·00?	1·82	5·11	0·49	0·00
H	4·54	5·86	48·06	58·51	87·53
N	0·00	0·00	4·56	5·18	6·91
	100·00	100·00	100·00	100·00	100·00

No hydrocarbon compounds of the olefiant series, capable of absorption by fuming sulphuric acid were found, nor any marsh gas. A very small percentage of the latter would have been readily detected. Tests were applied for sulphurous oxide, hydrogen sulphide, and chlorine, but there was no indication of the presence of these gases. A small amount of water vapor was driven off by the heat, but not apparently more than the ordinary quantum of hygroscopic moisture which such a substance would absorb from the air.

It will readily be seen, on reviewing the above results, that they show a marked distinction between the iron and the stony meteorites, as to the gases which they contain. For, while hydrogen is the principal gas of the irons, in the Lenarto specimen amounting to 85·68 per cent,* in those of the stony kind, if the one examined may represent the class, the characteristic gas is carbon di-oxide, and this, with a small proportion of carbonic oxide, makes up more than nine-tenths of the gas given off at the temperature of boiling water, and about half of that evolved at a low red heat. It is probable that a portion of the carbon di-oxide is merely condensed upon the finer particles of the iron, while the hydrogen and carbonic oxide are absorbed

* Graham, Proc. Royal Soc., xv, 502.

within it, as it is a familiar characteristic of iron, platinum and some other metals, that in the state of minute subdivision they take up large portions of gas by condensation. The gas thus fixed would be more easily liberated by heat than that really absorbed. This would explain the fact that the amount of carbon di-oxide given off was much greater at a low than at a high temperature, and that the percentage of the hydrogen increased, as was observed in all the trials, with an increase in the temperature to which the material was subjected.

The spectrum of the gases was observed by means of a vacuum-tube, of the kind ordinarily used for spectroscopic work, attached to the apparatus. As was to be expected, it consisted of the hydrogen and carbon spectra together, bearing a general resemblance to those of gases from iron meteorites, but differing from them in the greater relative intensity of the parts due to carbon compounds. At a few millimeters pressure, indeed, the hydrogen spectrum was almost overpowered by them, and was relatively weak. The three middle carbon bands, those in the yellow and green, were very bright, that in the green being most intense of all. In the broad part of the tube these constituted nearly the whole of the spectrum visible, the green hydrogen line being discernible with difficulty, and the others not at all.

These are precisely the three bands observed in the spectrum of some of the comets, and they have the same relative order of intensity. This is a very significant fact, for it shows that it is quite unnecessary to assume the existence of volatile hydrocarbons for the explanation of cometary spectra, as is done by some writers, and that the presence of the two oxides of carbon in such quantity is quite sufficient to account for all that has been observed, taking into consideration the circumstance that the tension of the gases in the cometary appendage must be extremely small, and the energy of the electric discharge very feeble.

There is a high degree of probability that, if a large comet should hereafter approach near enough to the sun to have its nucleus intensely heated, the hydrogen lines will be found in its spectrum, in addition to the bands heretofore observed. One cannot help regretting that a comet like Donati's should have departed into space just early enough to escape observation with the spectroscope.

The spectrum of bright lines or bands indicates that the gas gives out some light directly, in addition to that which it reflects The most obvious, and also the most probable cause, for this luminosity is electricity. Certainly a disturbance of the electrical equilibrium would result from the heating effect of the

solar rays, and a change of electrical potential, with consequent discharges, would be produced by the motion of the gaseous molecules from the nucleus and from each other, as also by the change in the distance from the sun, provided either of the bodies possessed an electrical charge, as can hardly fail to be the case.

There is another supposable cause for the light which suggests itself, however, in the property of gaseous bodies, that they emit light of the same character as that which they absorb. It is not altogether improbable that the solar radiations absorbed by the gaseous matter, though for the most part converted into heat, would also in part be emitted again as light, and that in the case of volumes of gas filling many cubic miles, the intensity might be sufficient to give a distinct spectrum of bright bands or lines, even though, on the scale of any possible experiment, no trace of such an action can be detected.

These results have thus an important bearing upon the theory of comets and their trains, and if this meteorite may be taken as a representative of its class, they warrant the following conclusions:

1. The stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the di-oxide, as their characteristic gases, instead of hydrogen.

2. The proportion of carbon di-oxide given off is much greater at low than at high temperatures, and is sufficient to mask the hydrogen in the spectrum.

3. The amount of the gases contained in a large meteorite, or a cluster of such bodies, serving as a cometary nucleus, is sufficient to form the train as ordinarily observed.

4. The spectrum of the gases is closely identical with that [illegible]

The loss of the gaseous contents by the action of solar heat readily explains the loss of the tail and diminution of brightness observed in the case of several comets in their successive revolutions, and their final disappearance from sight will follow as an inevitable consequence, the number of revolutions necessary to deprive them of their gaseous contents depending principally upon their size and the nearness of their approach to the sun at their perihelia.

The combustion of the hydrogen and carbonic oxide contained in meteorites, when liberated by the heat caused by their entrance into the atmosphere, must contribute greatly to increase the intensity of the heat, and both in this way, and by the consequent sudden expansion of the imprisoned gases, may have much to do with the bursting of the masses, and the violent detonations which attend their appearance.

Yale College, June 16, 1875.

ART. XII.—*Discovery of two new Asteroids;* by Professor C. H. F. PETERS. (Letter to one of the Editors, dated Ashfield Observatory of Hamilton College, Clinton, N. Y., June 6, 1875.)

Two new asteroids were found by me on the night of June 3, and observed as follows:

Asteroid (144) *Vibilia.*

1875, June 3, 15^h 3^m 2^s m. t.	$\alpha=17^h$ 21^m $8^s{\cdot}34$	$\delta=-23°$ $20'$ $57''{\cdot}2$
" 4, 11 17 58 "	17 20 18 ·75	−23 21 37 ·3

Asteroid (145) *Adeona.*

1875, June 3, 14^h 41^m 7^s m. t.	$\alpha=17^h$ 16^m $6^s{\cdot}85$	$\delta=-23°$ $4'$ $18''{\cdot}9$
" 4, 11 44 7 "	17 15 14 ·10	−23 6 41 ·0

The magnitude of (144) is estimated as the 10th, that of (145) as the 11·5th.

ART. XIII.—*The Discovery of a method of obtaining Thermographs of the Isothermal Lines of the Solar Disc;* by ALFRED M. MAYER.

ON June the 5th, 1875, I devised a method for obtaining the isothermals on the solar disc. As this process may create an entirely new branch of solar physics, I deem it proper that I should give a short account of it in order to establish my claim as its discoverer.

In the American Journal, July, 1872, I first showed how one can, with great precision, trace the progess and determine the boundary of a wave of conducted heat in crystals, by coating sections of these bodies with Meusel's double iodide of copper and mercury, and observing the blackening of the iodide where the wave of conducted heat reaches 70° C. If we cause the image of the sun to fall upon the smoked surface of thin paper, while the other side of the paper is coated with a film of the iodide, we may work on the solar disc as we formerly did on the crystal sections.

The method of proceeding is as follows: Beginning with an aperture of object-glass which does not give sufficient heat in any part of the solar image to blacken the iodide, I gradually increase the aperture until I have obtained that area of blackened iodide which is the smallest that can be produced with a well defined contour. This surface of blackened iodide I call the *area of* maximum temperature. On exposing more aperture of object-glass, the surface of blackened iodide extends and a new area is formed bounded by a well defined isothermal line. On again increasing the aperture another increase of blackened surface is produced with another isothermal contour; and on continuing this process I have obtained maps of the isothermals of the solar image. By exposing for about 20 minutes the surface of iodide to the action of the heat inclosed in an isothermal, I have obtained thermographs of the above areas; which are sufficiently permanent to allow one to trace accurately their isothermal contours. There are other substances, however, which are more suitable than the iodide for the production of permanent thermographs.

The contours of the successively blackened areas on the iodide are *isothermals*, whose successive thermometric values are inversely as the successively increasing areas of aperture of object glass which respectively produced them.

As far as the few observations have any weight, the following appear to be the discoveries already made of this new method. (1) There exists on the solar image an area of sensibly uniform temperature and of maximum intensity. (2) This area of maxi-

mum temperature is of variable size. (3) This area of maximum temperature has a motion on the solar image. (4) The area of maximum temperature is surrounded by well-defined isothermals marking successive gradations of temperature. (5) The general motions of translation and of rotation of these isothermals appear to follow the motions of the area of maximum temperature which they inclose; but both central area and isothermals have independent motions of their own.

On projecting the enlarged image of a sun-spot on the blackened surface and then bringing a hot water box, coated with lamp-black, near the other side of the paper, one may *develop* the image of the spot in *red* on a dark ground. A similar method probably may serve to develop the athermic lines in the ultra-red region of the solar and other spectra.

South Orange, N. J., June 11th, 1875.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Action of a Weaker Acid on the Salts of a Stronger one.*—The importance in chemical dynamics of the question, what is the condition in which several substances exist when in solution, has been oftener recognized than experimentally investigated. Bergmann advanced long ago the theory which is now generally maintained; i. e., that universally bodies combined according to the strength of their chemism. Berthollet, on the other hand, asserted that when different salts were dissolved together, as many bodies were formed as, by the exchange of acids and bases, were possible. Among the experiments made to settle this question, those of Bettendorff* are perhaps the most satisfactory. By studying the action of light on certain solutions, he was led to decide for the view of Bergmann. Hübner and Wiesinger, not regarding these experiments of Bettendorff's as sufficiently numerous or comprehensive. have made use of a different method of solving the problem, by making the distinct proposition: Can a dissolved acid expel a stronger acid from one of its salts in solution, without any substance separating from the solution? For these experiments, they used benzoic acid for the weaker and nitrobenzoic acid for the stronger acid. They are both monobasic, are easily obtained pure, are easily separated from each other and from their salts, and can be recognized with certainty. They differ only, apparently, in the strength of their chemism. In the qualitative experiments, barium nitrobenzoate and free benzoic acid were dissolved in a large excess of water, the solution being heated to 80° C. After cooling to 14–17° the solution contained not only the substances originally dissolved, but also free ni-

* Zeitschr. Chem., 1866, 641.

trobenzoic acid and barium benzoate. The nitrobenzoic acid set free in the reaction, together with the benzoic acid also present, was dissolved by agitation with chloroform or benzol, in which the barium salt is insoluble. In the residue, after the solvent was distilled off, the presence of nitrobenzoic acid was proved by means of sodium. In a qualitative experiment, 1·6592 grams pure barium nitrobenzoate was mixed with the theoretical quantity, 1·1815 grams, of pure benzoic acid and dissolved in an excess of hot water. The cold solution was agitated with chloroform, the latter removed with a pipette, the solvent distilled off, and the residue freed from benzoic acid by a current of steam. The nitrobenzoic acid thus obtained was pure, and weighed 0·2341 grams, being 19·81 per cent of the acid contained in the barium salt used. Additional experiments seemed to show that the quantity of the stronger acid thus set free is dependent on the quantity of the weaker acid present.—*Ber. Berl. Chem. Ges.*, viii, 466, April, 1875. G. F. B.

2. *On Iodous Chloride.*—BRENKEN has examined, in the laboratory of Lothar Meyer, the formation and properties of iodous chloride, ICl_3. It was prepared by passing dry chlorine over dry iodine, the former being in excess. It is purified by repeated sublimation in a stream of dry chlorine; and then appears as a lemon-yellow crystalline sublimate upon the walls of the tube. Contrary to the statements of the text-books, it does not fuse, even in an atmosphere of chlorine; but even at 25 C. it suffers dissociation into chlorine and hypoiodous chloride, which latter it is that fuses. Under an atmosphere of increased pressure, the dissociation took place at 67°, the constituents reuniting as the tube cooled. In a sealed tube, the decomposition requires a temperature of 86°. If two pretty strong tubes containing iodous chloride be sealed and heated to 70° or 80°, their contents remain yellow. But if now the point of one of them be softened in a gas flame, it will be blown out by the interior pressure, the dissociated chlorine will escape, and the fused brownish red hypoiodous chloride will be left on the walls of the tube. At a still higher temperature, the ICl_3 in the unopened tube dissociates. Closing the opened tube again, and cooling both tubes, the unopened tube contains the yellow iodous, the opened one the brown red hypoidous chloride ICl, which remains for a long time liquid. Experiments to produce a liquid chloride resulted negatively.

In the following paper, MELIKOFF gives the results of his attempts to determine the vapor density of iodous chloride. He concludes that this vapor at the temperature of 77°, and under one atmosphere of pressure, even in presence of an excess of chlorine, decomposes completely into hypoiodous chloride and chlorine.—*Ber. Berl. Chem. Ges.*, viii. 487, 490, April, 1875. G. F. B.

3. *On the Paraffins of Pennsylvania Petroleum.*—MORGAN, under Schorlemmer's direction, has made an examination of the normal hexane and heptane from Pennsylvania petroleum, to test the question of the presence of isomers. The normal paraffins were chlo-

ıated, and then converted into olefines by treatment with alcoholic ·tash. These olefines were treated with cold hydrochloric acid, ch of them being thereby separated into two fractions, one of ɪich dissolved in the acid, while the other did not. The latter ıctions yielded secondary alcohols when suitably treated, that ɔm the hexane being methyl-butyl carbinol and that from the ·ptane being methyl-pentyl carbinol. It hence appears that the ·rivative olefines are normal, and have the constitution $CH_2=CH$ $\cdot C_nH_2 2n+1$. The former olefines, i. e., those soluble in hydro- ıloric acid in the cold, yielded alcohols which appeared to be condary, but which need further investigation.

In some remarks upon this paper, SCHORLEMMER says that the ɔove results do not necessarily prove the presence of a third iso- eric heptane in petroleum. Heptane when treated with chlorine ields one primary, and may yield three secondary chlorides. ' the heptenes from two of these combine with hydrochloric :id in the cold, the alcohols from them would yield on oxida- on ethyl-butyl ketone and dipropyl ketone. These on further ɪidation would yield propionic and butyric acids. Since Morgan ɔtained the latter, and as the acetic acid he obtained came prob- ɔly from the presence in his heptane of a lower-boiling isomer, it probable that, owing to the method he employed, the propionic :id was overlooked. To decide the question an absolutely pure ıraffin is necessary; and the author proposes to make additional :periments with hexane from mannite.—*J. Chem. Soc.*, II, xiii, ɔı, April, 1875. G. F. B.

4. *Action of Ammonium chloride on Methyl alcohol.*—WEITH ıs satisfactorily shown that when ammonium chloride is heated ith a sufficient excess of methyl alcohol, it is completely con- ·rted into methylamine chlorides. In one experiment two grams H_4Cl and 12 c. c. $CH_3(OH)$ were heated together in a sealed ıbe to 280–285° for ten hours. No deposit appeared in the tube ı cooling, the liquid existing in two layers. On opening the tube e lighter layer disappeared as a gas, which was proved to be methyl her $(CH_3)_2O$. The remaining liquid did not contain a trace of nmonium chloride. It was distilled with barium hydrate, the stillate being collected in alcohol and examined. No trace of ethylamine or of dimethylamine could be detected. The residue om the evaporation of the alcohol, treated with platinic chlor- ıe, gave pure trimethylamine chloroplatinate. Pushing the dis- llation still further, alkaline vapors were evolved, and the solu- on afforded on examination tetra-methyl-ammonium chloride. ;uantitative experiments showed about 8 per cent of the NH_4Cl ·as converted into the tertiary base; the rest yielded tetra-me- ıyl-ammonium chloride. Ethyl alcohol acts differently, scarcely trace of amine resulting.—*Ber. Berl. Chem. Ges.*, viii, 458, April, 875. G. F. B.

5. *On Glyceryl ether.*—This ether, first discovered by Linne- ıann and von Zotta, is prepared by dehydrating glycerin by ıeans of calcium chloride. VON ZOTTA has re-investigated the

conditions of its formation. To prepare it 300 grams of dry glycerin were heated to 190° with 45 grams calcium chloride in a balloon of 900 c.c. capacity, until it frothed nearly over. The distillate, freed from the more volatile matters, was agitated with ether, which was removed and evaporated. It left about 22 grams of a product boiling between 150° and 240°. The glycerin was again treated in the same way, so that finally it yielded about $\frac{1}{4}$ its weight of a product boiling between 160° and 210°. This was agitated with potassium hydrate solution to remove the phenol, and rectified. Pure glyceryl ether was thus obtained boiling between 171° and 173°. Treated in this way 14·8 kilos. of glycerin yielded 250 grams of pure glyceryl ether and 18 grams of pure phenol. Glyceryl ether $(C_3H_5)_2O_3$, is an oily liquid miscible with water, alcohol and ether. Specific gravity at 16° is 1·16. On boiling its aqueous solution, it changes to glycerin. Treatment with bromine converts it into dibromhydrin. Solid potassium hydrate acts on it to produce phenol.—*Bull. Soc. Ch.*, II, xxiii, 310, April, 1875.

G. F. B.

6. *On the Purification of Salicylic Acid.*—The commercial importance now attaching to salicylic acid, makes it desirable to contrive a method for purifying it. The methods by which it is manufactured leave it strongly colored; and Kolbe's method for purifying it by converting it into ether, entails so much loss as to be practically useless. Since it cannot be sublimed without decomposition, alone, this method is impracticable; but Rautert has succeeded in subliming it completely in a current of superheated steam, and in this way readily obtaining it pure. Recrystallization from hot distilled water gave the salicylic acid in beautiful snow-white crystals.—*Ber. Berl. Chem. Ges.*, viii, 537, April, 1875. G. F. B.

7. *On a New Method of Testing Quinidine Sulphate.*—Hesse proposes a new method of testing quinidine sulphate, founded upon the action of ammonia and water upon its iodhydrate, as compared with the iodhydrates of quinine, cinchonine and cinchonidine. Half a gram of the sulphate to be tested is warmed to 60° C. with ten cubic centimeters of water, half a gram of potassium iodide is added, well stirred, allowed to cool and after an hour, filtered. If the specimen was pure, the filtrate remains clear upon the addition of a drop of ammonia. If a precipitate is produced, quinine, cinchonine or cinchonidine is present. A less delicate test, but one commercially satisfactory, is as follows: Half a gram of the material is digested at 60° for about five minutes with 40 c.c. of water, and then mixed with three grams of potassio-sodium tartrate (Rochelle salt). If the specimen contains but little or no quinine or cinchonidine, the solution remains clear; if not, a precipitate appears, when the admixture amounts to six per cent. This precipitate, after standing an hour, is filtered off, washed with a little cold water, and the filtrate after warming is mixed with half a gram of potassium iodide. If quinidine be present, a precipitate of quinidine iodhydrate is produced. In

his case, the liquid is allowed to stand an hour, filtered off, and a rop of ammonia added to the filtrate. A precipitate indicates he presence of cinchonine, in amount at least two per cent. The resence of calcium and sodium salts in the quinidine sulphate is eadily detected by solution in chloroform when these are left beind. If quinine or cinchonidine are also present, one gram of the ubstance is to be treated with seven cubic centimeters of a mixure of two volumes chloroform and one volume 97 per cent lcohol.—*Liebig's Annalen*, clxxvi, 322, May, 1875. G. F. B.

8. *Mechanical Equivalent of Heat.*— M. H. J. PULUJ has deised an apparatus of very simple construction for measuring this onstant, suitable for use in the lecture-room. It consists of a alorimetric and dynamometric portion, suitably connected with an scillation machine, such as is found in every physical cabinet. The calorimetric part is formed by two hollow truncated cones of ast-iron, one fitting into the other, the inner not quite reaching o the bottom of the outer, and appearing a little outside of it. The outer cone can be fixed coaxially in the vertical bobbin of the nachine. The inner cone contains mercury. If the machine is put n motion and the inner cone fixed, heat is generated by the friction of the surfaces.

An arrangement which is an inversion of Prony's check serves or the measurement of the work which is converted into heat. On he wooden lid of the inner cone a light wooden beam is screwed iorizontally. A perforation passing through the beam and lid reeives the thermometer. At some distance from the beam is a fixed ulley, on a level with it, over which a thread, to which a scale is uspended, is slung and is fastened to the end of one arm of the eam; the other arm serves as a counterpoise. When the machine s set in motion, the interior face of the outer cone rubs against the urface of the inner one and tends to turn the beam, which is fasened to the latter, in the direction of the motion. With a certain oad the horizontal part of the thread and the axis of the beam will include a right angle. From the length of the beam-arm, mount of the load and number of rotations, the work converted nto heat, and from the water value of the calorimeter and the rise of temperature, the quantity of heat generated, can be calculated.

The memoir contains also the development of the theory of the apparatus, taking into consideration the heat radiated from the calorimeter, and finally the numerical calculation of the values of the nechanical equivalent of heat from 28 experiments. The mean of he results, the 425·2, with the mean error ±5·4, is in excellent accordance with Joule's result, 424·9, and may be regarded not nly as a fresh corroboration of it, but also as a measure of the accuracy with which the experiments can be conducted by means of this simple apparatus; these occupy but very little time, an experiment proper lasting but 30–60 seconds, on which account the apparatus may be recommended for lecture-experiments.—*Roy. Acad. Vien.*, April, 1875; *Phil. Mag.*, xlix, 416. E. C. P.

9. *Action of Magnets on Geissler Tubes.*—M. J. Chautard has studied somewhat at length the effect of a magnet on rarefied gases enclosed in capillary tubes, illuminated by an induced current. The gases or vapors employed were H, N, O, CO_2, CO, C_2H_4, S, Se, I, Br, Cl, SO_2, SiF_4, $SnCl_4$. Bodies of the chlorine family are those which gave the most concordant and brilliant effects. An increase of temperature diminishes the action of the magnet. This is shown by allowing the current to pass for some time, when the magnetic influence is enfeebled or destroyed. The presence of the gas is an important element to be considered, as by varying it the current may be intercepted or the appearance of the light greatly altered. Similar effects are attained by varying the strength of the current, and are most marked when the current is feeble. The phenomena are the same whether a Holtz machine or coil are used as a source of electricity, and are independent of the direction through the coil or gas. The form of the armatures is important; they should be plain and surround the tube for the greater part of its length. The effect of a single pole is slight, or of both poles when more than five millimeters distant from the tube.

The stoppage of the current by the magnet was shown by using two tubes, one of which was greatly narrowed and placed between the poles. As long as the magnet did not act the current passed through both tubes, but on closing the circuit the light was immediately extinguished in the narrow tube. This experiment succeeds best with Cl, I, S and Se. The cessation of the light occurs in two distinct cases, when the pressure is so slight that the current will scarcely pass, or when it is sufficient for the spark to attain nearly the same limit. Under the action of the magnet the luminous thread undergoes a contraction sometimes visible to the naked eye. An alteration in the color or in the spectrum is sometimes thus produced. This effect is scarcely perceptible with H, N and CO_2. The narrowing does not extend more than a few millimeters from the poles, so that with a tube of sufficient length we can, by varying the position of the spectroscope, view first the normal spectrum, and then that due to the magnet. The change is most marked with Cl, Br, $SnCl_4$, SiF_4, SO_2. Direct measures have shown that with these gases the new rays thus developed are wholly distinct from those characterizing the normal spectrum of the same gas.—*Comptes Rendus*, lxxx, 1161. E. C. P.

10. *Effect of Electricity of high tension on Liquids.*—M. G. Plante has applied his secondary pile to the study of these phenomena. The gradual diminution of the current, instead of being an objection, has the advantage that, without changing the other conditions, it enables us to study the effect of currents of every strength less than that first employed. Two batteries, each of twenty cells, were charged and connected with a wire 80 cms. in length, and 1 mm. in diameter. A voltameter was also placed in the circuit with electrodes of platinum wire, the positve wire only being immersed. When the negative electrode was placed in the liquid, a sheath (*gaine*) of light was produced around it,

; sensible disengagement of gas; the other electrode set free gas, and the wire was not heated to redness. After two or ninutes, however, the sheath of light disappeared, gas free abundantly at both electrodes, and the wire at the stant was heated to redness. To show these effects still ten batteries were used, equivalent to 300 Bunsen cells, con- for tension and capable of heating to redness a platinum wire ers in length and 3 mms. in diameter. These batteries are l by two Bunsen cells in the course of an hour. Repeating ve experiment with them, the wire, on touching the liquid, r volatilized with a flame variously colored, according to al employed. If the liquid merely contained traces of acid, avoid complete fusion of the metal, a continuous series of were produced with a noisy crackling like the discharges of action coil, and lasting sometimes several minutes. The markable effect was obtained with a saturated solution of n salt. The voltameter being so mounted that the wires e very gradually immersed, the negative pole was first l in about a millimeter, and the positive terminal then made h the surface. A small luminous and perfectly spherical hen formed around it with a loud rattling noise; raising the increased in size until it had attained a diameter of nearly meter, and then, on lowering the wire, began to revolve . After attaining a certain speed, it detached itself as if d by the other electrode, and disappeared with an explosion me at the negative pole. This globule is not gaseous but n a speroidal state, illuminated by the current it transmits. ad of immersing the wire it is brought near the glass sides essel, a bright flash of a curved or zigzag form darts over nce of three or four centimeters to the electrode, with an ex- as before. Soon after another spark is formed, and so on eral minutes. These luminous balls present a marked re- nce to, and offer a probable explanation of, the curious phe- known as globular lightning. The cloud and earth form trodes, and the moist air replaces the liquid. Probably the the case of lightning, are not liquid, but are formed of ble matter charged with electricity. These experiments the probability, if it is ever possible to try the experiment, lls of lightning are charged with positive electricity.— s *Rendus*, lxxx, 1134. E. C. P.

II. Geology and Natural History.

reenland Glaciers: Subglacier rivers.—Prof. Nordenskiöld d thirty miles inland on the Great Greenland glacier and ts surface there to be only 2,000 feet above the sea, showing e land over the interior must be comparatively low—and ower than the islands bordering it, which average 2,000 height In summer, the snow which covers the glacier nd rivers of ice-cold water flow over the surface and

descend in the crevasses to unknown depths. These crevasses are exceedingly numerous, and apparently increase in number on passing toward the interior, where not a plant, or stone, or patch of earth is seen over the great ocean of ice and snow, 1,200 miles in extent from north to south and 400 in breadth. Dr. Rush believes that the outpour of the Greenland precipitation of snow and rain in the form of glacier ice amounts to only two inches, while he estimates the fall at twelve inches; so that, as the evaporation must be very small, a large portion of the remaining ten inches must be carried off by subglacier rivers.—"Nature" of April 8th, from which these notes are taken, has a geological map of the Arctic region between the meridians of longitude 20° W. and 80° W., prepared by Mr. C. E. De Rance, the author of a series of papers on the Arctic regions, in the same Journal.

2. *Bulletin of the U. S. Geological and Geographical Survey of the Territories:* Nos. 2, 3 and 4, second series. 68 pp. 8vo, with maps and plates. Washington, May 15th, 1875.—The papers contained in number 2 are: Monograph of the Genus *Leucosticte* of Swainson, or gray-crowned purple Finches, by Robert Ridgway; the Cranial and Dental Characters of Geomydæ, by Dr. Elliott Coues; Relations of Insectivorous Mammals, by T. Gill; on the Natural History of the U. S. Geological Survey of the Territories for 1874 (a list of the Mollusks), by Ernest Ingersoll. Number 3 contains the following papers: Means of Communication between Denver and the San Juan Mines, by A. D. Wilson; on the Mines and Geology of the San Juan Country, by F. M. Endlich; on the Topography of the San Juan Country, by F. Rhoda; on some peculiar forms of erosion in Eastern Colorado, with heliotype illustrations, by F. V. Hayden. No. 4 contains reports on the features of the Colorado or Front Range of the Rocky Mountains, by F. V. Hayden, with a number of plates; on the Tertiary Physopoda of Colorado, by S. H. Scudder; on a Natural Arrangement of the Falconidæ, by R. Ridgway.

Mr. Endlich, in his remarks on the San Juan Country, states that for more than 4500 square miles, the surface is covered continuously with volcanic rocks. The following succession of strata was observed: (1) 800 feet of trachyte, mostly light-colored; (2) 1200 feet of red to brown trachyte, containing sanidite and some mica; (3) 2000 to 2250 feet red to brown trachyte; (4) 3000 to 4000 of trachyte of various characters, making in all a thickness of 7000 to 8000 feet. Above follow doleritic beds.

The veins of the region, affording argentiferous galenite, sphalerite, tetrahedrite, brittle silver, etc., and some of them gold, occur in the trachyte, and are referred to the Cretaceous or the beginning of the Tertiary, the era of the trachytic eruptions.

Going south and west the volcanic strata thin out, revealing the rock they overlie. Near the head of Cunningham Creek the volcanic rocks form the crests of ridges, while the valleys cut through into metamorphic rocks, which are quartzyte, chloritic rocks, mica schist, staurolitic schist, gneiss, and a coarse-grained granite.

ates illustrating the brief reports of Dr. Hayden are ex-

g the results of the same expedition, under the Interior ent, there have recently appeared also—(1.) A "Prelim-.p of Central Colorado," showing the region surveyed in l 1874; Primary triangulation by G. T. Gardner, topogra-3. R. Bechler, H. Gannett, A. O. Wilson and S. B. Ladd. colored Geological map of the sources of the Snake River tributaries, and of portions of the headwaters of the Yel-, by G. R. Bechler, topographer, and Frank H. Bradley, t.

colored Geological map of part of Montana and Wyo-rritories, embracing most of the country drained by the , Gallatin and Upper Yellowstone Rivers; Geology by ayden, assisted by A. C. Peale; drawn by H. Gannett tes and sketches by A. Burck, chief topographer of the ;one division. It has contour lines.

ond Geological Survey of Pennsylvania, 1874. Report)n the Mineralogy of Pennsylvania, by F. A. GENTH. n Appendix on the Hydro-carbon Compounds, by S. P. ; 206 pp. 8vo. Harrisburg, 1875.—Dr. Genth has in-) this volume the results of his long study of Pennsylvania , with many facts obtained from others who have labored me field. The minerals are arranged according to the dopted in Dana's Mineralogy, and under each species is a few words, its chief characteristics, and then in more e description of the localities in the State. Dr. Genth d also a large number of new analyses recently executed elf.

t "J." On the Petroleum of Pennsylvania, by HENRY E. Y. With a map and profile of a line of levels through Armstrong, and Clarion Counties, by D. J. Lucas; also a profile along Slippery Rock Creek, by J. P. Lesley. 8vo. Harrisburg, 1875.—Mr. Wrigley treats of his sub-ll its bearings, historical, geographical, geological and cal; his report will be found of great value by all in-in the subject.

port upon the Reconnaissance of Northwestern Wyoming, g Yellowstone National Park, made in the summer of y Wm. A. Jones, Captain of Engineers U. S. A. 326 pp. h numerous maps.—This volume consists of a General f the region explored by Captain Jones; an Astronom-ort, by Lieut. S. E. Blunt; a Geological and Archæolog-Philological Report, covering 200 pages, by Prof. T. B. k; a Report on Mineral and Thermal waters, by Surgeon rzmann; a Botanical Report by Dr. C. C. Parry, and an ogical Report by J. D. Putnam.

eport of Prof. Comstock gives much information on the and structure of the region, with details respecting the nd hot springs of the Yellowstone Park. The Lower

Silurian of the Primordial and Canadian periods was observed, and perhaps Upper Silurian beds, but no Devonian, the next strata overlying being Carboniferous; whether the Subcarboniferous is included he leaves doubtful. Above the Carboniferous come the Triassic, Jurassic, Cretaceous and Tertiary. A colored geological map of the region accompanies the Report.

5. *Report of Progress of the Mineralogical, Geological and Physical Survey of the State of Georgia for the period from Sept.* 1 *to Dec.* 31, 1874; by GEORGE LITTLE, State Geologist.—This Report of progress gives brief notices of some of the mines and ores of the State, with also accounts of valuable localities of marble, roofing slate, mica for stove doors and other utensils of economical value, with a notice of some of the localities of minerals. There are also analyses of limonite, dolomite, limestone, etc.

6. *Michigan, being condensed popular sketches of the Topography, Climate and Geology of the State;* by A. WINCHELL, LL.D., late Prof. of Geology, Zoology and Botany in the University of Michigan. 122 pp. 8vo. 1873. Extract from Walling's Atlas of Michigan.—This is a valuable résumé of the results obtained by Prof. Winchell in his investigations into the Topography, Geology, and Climate of Michigan. The volume is accompanied by four maps—one a topographical map with contour lines; the second a colored geological chart of Michigan prepared from the latest observations; and the other two climatological charts, giving the isothermal lines for spring, autumn, and the year.

7. *Analysis of Ægirite from Hot Springs, Arkansas;* by J. LAWRENCE SMITH.—The occurrence of ægirite at Hot Springs (Magnet Cove), Arkansas, was first noticed by C. U. Shepard in this Journal, vol. xxxvii (p. 407), for 1864. The following are the results of my analysis of the mineral:

Silica,	51·41
Alumina,	1·82
Peroxide of iron,	23·30
Protoxide of iron,	9·45
Lime,	2·03
Magnesia,	0·31
Soda, with *trace of potash*,	11·88
Titanic acid,	·13
	100·33

The specific gravity is 3·53.

8. *Second Appendix to Dana's Mineralogy;* by EDWARD S. DANA; 64 pp. 8vo. New York, March, 1875. (John Wiley & Son.)—The first Appendix to Dana's Mineralogy was prepared in 1872, by Prof. G. J. Brush. The present Appendix follows that after an interval of three years, and is intended to make the work complete up to 1875. It includes full descriptions of 92 mineral species announced as new since March, 1872, with also explanations of a considerable number of other names new to the science but not properly belonging to distinct species. It also embraces references to all mineralogical articles published in the many

Journals since the issue of the Mineralogy in 1868; these references are placed under the name of each species, to which the article relates, the species being arranged alphabetically. This Appendix is consequently an index to all the mineralogical literature of the past seven years. A list of mineralogical books and of important general memoirs covers the few opening pages.

9. *Mineralogical Contributions*, V., by Prof. C. KLEIN, in Heidelberg.—Prof. Klein has investigated with great minuteness the crystals of octahedrite (anatase) from the Binnenthal. He distinguishes four distinct types of forms, and shows that they are remarkable for their large number of planes. He also proves it to be very probable that the mineral from this locality which was described by Kenngott as wiserine is in reality octahedrite.

E. S. D.

10. *On the presence of Vanadium in rocks.*—Dr. A. A. Hayes, in a paper read before the American Academy of Sciences, Boston, in January last, states that he had detected vanadium in many rocks associated usually with compounds of phosphorus and of manganese. His mode of examination for the detection of vanadium is described in detail, but no complete analyses of any rocks are presented. The author proposes in a future paper to give a tabulated list of the rocks. He also states the occurrence of vanadium in the well water of Brookline, near Boston.

11. *Pseudomorph after crystals of Labradorite from Verespatak;* by G. TSCHERMAK.—Feldspar-like crystals occur in the quartz-andesite of Verespatak, Transylvania, which are pseudomorphs after labradorite. Their form, however, is in many cases well retained, though the luster of the planes is gone. They were found to be twins in all cases, the several laws of twinning being similar to those often observed in orthoclase. Sometimes the crystals are very complex, being made up of a number of individuals. They have a snow white or sometimes yellowish color and earthy fracture, and though firm in the fingers are easily ground in the mortar to a soft, white powder. An analysis gave Sipöcz:

$\ddot{S}i$ 55·96, $\bar{\bar{A}}l$ 31·34, $\bar{\bar{F}}e$ 1·16, $\dot{M}g$ 1·73, $\dot{C}a$ 0·65, $\dot{N}a$ 0·18, $\dot{K}a$ 4·96, $\dot{H}$ 5·41 = 101·39

Under the microscope the mass is seen to consist of two kinds of minerals in fine scales: one colorless, the other slightly greenish and having the appearance of a potash-mica, to which it is referred by Tschermak. Deducting from the above analysis the latter, which amounts to about one-fourth of the whole, and also deducting some unchanged feldspar, limonite, etc., present in small quantities, Professor Tschermak finds that the remainder corresponds to the formula, $3\ddot{S}i$, $\bar{\bar{A}}l$, $\dot{H}$, which he regards as expressing the composition of the colorless scaly mineral referred to, it being thus a hydrous alumina silicate differing from kaolinite. The change which has taken place in the original material consists essentially in an exchange of potash for soda, and of water for lime. This loss of lime has been often observed in other similar cases.—*Tsch. Min. Mitth.*, 1874, iv, p. 269.

E. S. D.

12. *Fungi; their Nature and Uses;* by M. C. COOKE, M.A., LL.D., edited by Rev. M. J. BERKELEY, M.A., F.L.S.—*The International Scientific Series.* Appleton & Co., New York. 1875. pp. 299.—The earlier volumes of the International Series which have come under our notice were so excellent, that it may not be reasonable to expect all their successors to come up to the same standard. Moreover, in such a treatise as the present, we are not to look for any substantial addition to our knowledge, but rather for a good popular exposition of what is already known in the science, including the interesting and important discoveries of the last few years, much of which has not yet been made available to general students or amateurs, at least in the English language. A book upon this subject, at once plain, practical and scientific, but not over-technical, calculated to subserve the wants of students and gratify a general interest, was much wanted, and we may add, is in a good degree wanting still. The expectations which the honored name of Mr. Berkeley upon the title-page inspired are diminished by his prefatory announcement, that, although he had promised to write the book, he had been obliged, through ill health and manifold engagements, to turn over the work to Mr. Cooke; but that he had editorially read the manuscripts and the proofs, subjoining some notes. The volume is therefore substantially that of Dr. Cooke, although we may conjecture that the chapters on the uses and notable phenomena of Fungi owe much to the veteran English mycologist's store of information.

The important chapters on the nature, structure, reproduction and classification of Fungi are not so satisfactory; partly because the plan of the work breaks up and widely separates matters which must need be connected to give a clear idea of the life-history of any fungus; partly because too many topics are entered upon and dropped without adequate explanation, and too many technical terms are used without explanation; and sometimes, it would seem, from imperfect apprehension of German [redacted]

More to the purpose would have been some account of hods of study adopted by modern investigators who have given a new and deep interest to mycology. Useful as this must be, and full as it is of interesting information about it does not altogether supply the long-felt want of an ary text-book. A. G.

Estivation in Asimina.—The æstivation was formerly to be valvate in all *Anonaceæ*. In the Genera Am. Bor. strata, vol. i, 1848, it is mentioned that the petals of each more or less imbricated in *Asimina*, as also in some other The petals enlarge so much before and during expansion proper æstivation needs to be determined in young flower-A subsequent examination of these, in *A. triloba*, showed re was hardly any overlapping in an early state. Accord-the later editions of my Manual, no exception to the character, "valvate in the bud," is alluded to. In the Plantarum, Bentham and Hooker distinguish their two *Uvarieæ* and *Unoneæ* by the æstivation of the petals,—more imbricated in the former, valvate in the latter, to which fer *Asimina*. Last spring I had an opportunity to ex-on the living plants and flower-buds of *A. grandiflora*, the in which the exterior petals are most accrescent, and the perhaps least so, the one which most resembles *Uvaria* in earance of the blossoms. The sepals appear to be truly The outer petals are decidedly imbricated, their tips verlapping in the order 1, 2, 3, in the early bud, and ng so during the great enlargement; but down the sides not overlap, nor are their bases contiguous. The inner re remote in bud: moderately accrescent, they remain pro-lly small, and from first to last do not come into contact, rgins above the middle becoming revolute in anthesis, ie base grows more and more deeply concave and papillose-This portion is frequented by thrips, or such-like insects, s the mass of stamens as soon as the anthers open. The are proterogynous, the stigmas being early in good condi-e anthers discharging pollen only when nearly ready to and fall.

xamining good fresh flower-buds of *A. triloba*, in May, I it the sepals are truly valvate at first, but separate more as the bud swells. The exterior petals, a little distant at ses, very slightly overlap as they meet at the summit, st below the margins become a little revolute. The inter-ls are similar, but rather more distant at base, and rather curely, yet very slightly, overlapping at the very tips. increase in size they slightly assume the imbricated posi-ich becomes conspicuous in the outer petals.

lude that the tribe *Unoneæ* cannot be distinguished from rieæ, at least upon the characters assigned, and that the l of æstivation passes by gradations into the other.

A. G.

14. *Text-book of Botany: Morphological and Physiological:* by JULIUS SACHS, Professor in the University of Würzburg: translated and annotated by A. W. BENNETT, M.A., and W. J. THISTLETON DYER, M.A. 858 pp. large 8vo. London. (Macmillan.) —The third and fourth editions of Sach's German treatise, and Van Tieghem's French translation of the third, have been noticed in this Journal. In point of mechanical execution, the volume now under consideration compares very favorably with its predecessors, which have received high praise. The translation into English is based, like Van Tieghem's, on the third German edition, and one is therefore tempted to first compare English with French editing. Considered as a translation merely, the former is superior. It is very close, idiomatic, and as clear as the original. In some instances the selection of English words to convey the expression involved in a compound German word is most felicitous. Considered as an annotated revision, the English edition is inferior. The solid pages, for instance those devoted to *Tension*, remain as in the German, whereas in the French, skillful paragraphing has rendered the whole far easier of reference. The use of significant headings for the paragraphs has enabled Van Teighem also to give a synoptical table of contents of much value. It has been shown in a previous notice that Van Tieghem's table presents a clear and exhaustive outline of the whole work. Nothing more than a list of sections replaces this in the present volume. This lack, having been so well met by a French editor, is all the more apparent and regretable. With this our adverse criticism is exhausted. This conscientious translation is a valuable and timely gift to botanical students; that our American fellow students may be more ready to welcome it, we present a sketch of the work.

The Text-book is divided into three parts: General Morphology, Special Morphology and Physiology. The first treats of the nature and forms of cells, the formation of cells, the structure of the cells, their constituent parts and occasional contents. Tissues defined as aggregates of cells which obey a common law of growth are next considered with reference to their formation and forms. Three systems of tissues are fully described, epidermal, fibro-vascular bundles, and fundamental. Here are presented comprehensive studies of laliciferous and vesicular vessels, sap-conducting intercellular spaces and glands. The primary *meristem*, the uniform tissues made up of cells, all of which are capable of dividing, is next treated of in connection with the terminal *point* of growth. Here a somewhat confused terminology (Hanstein's) is introduced. Frequent cross-references to illustrations further on would have made this free from the ambiguity which now characterizes it. The fault lies, however, at the door of the German abstract of Hanstein's and Reinke's work. The outward shapes of plants, differences between structural members and working organs, and metamorphosis, come next. Most of this chapter is a literal translation of the least satisfactory portion of the third edition. Much of it has been rewritten in the fourth German, and for the better.

Book second is wholly devoted to special morphology and outlines of classification. The former is based on excellent abstracts of monographs and is most serviceable. The "outlines" are of little use to our botanists except as an illustration of what systematic botany would become if it were left to the physiologists. Already since this edition was written, Prof. Sachs has changed his system; and it is still in a state of unstable equilibrium, or want of equilibrium. There is hardly a more profitable task for a young botanist than the comparison of the systematic sections of Book Second with Dr. J. D. Hooker's appendix to the English translation of De Maout's and De Caisne's work. The former is by a physiologist, the latter by a morphologist. Vegetable Physiology is given in Book Third. The excellence of this digest is apparent on a hasty perusal. It becomes more obvious when the book is used with advanced students as a hand-book in daily work. From constant use of the German and French versions in the laboratory during the past year, by students of two grades, the present writer can give it honest praise. When it is supplemented by the Experimental Physiology of the same author, the laboratory is well equipped. Vegetable Physiology is treated of under the following heads; Molecular forces in the plant; Chemical processes in the plant; General conditions of plant-life; the Mechanical laws of growth; Periodic movements of the mature parts of plants, and movements dependent on irritation; the Phenomena of sexual reproduction; the Origin of species. In addition to the copious citations made by Prof. Sachs, the translators have given many references to memoirs now accessible to English students in translations or abstracts. It seems to have been the aim of the editors to render the work of the greatest value to botanical students who are unfamiliar with German. It is a great pleasure to commend this volume, most heartily, as a good translation of the German hand-book to advanced botanical students. G. L. G.

15. *Zur Abwehr der Schwendener-Bornet'schen Flechtentheorie* (Contribution to a refutation of the Schwendener-Bornet Lichen theory); by Dr. G. W. KOERBER. 30 pp. 8vo, Breslau, 1874.—In this essay Dr. Koerber, one of the first Lichenologists of Europe, has cast the weight of his authority against the theory which has received considerable currency, that Lichens are a compound of an Alga (the gonidia) and a Fungus (the hyphæ). He maintains, first, that the "nicht-gonimische," i. e., the hyphæ, and the lichens themselves are not Fungi, citing, in support of this proposition, the known chemical and other differences between the two, and the fact that many lichens are altogether destitute of hyphæ. He is curious to know how, on the theory of Schwendener, the formation of a thallus from the copulation of Fungoid hyphæ and an Alga can be explained. Secondly, he maintains that the gonidia of Lichens are not Algæ, because: 1, in true Algæ the gonidia never produce hyphæ, while this is of common occurrence in the spores of Lichens; 2, that if the contrary were true, it is strange that in every Lichen several types of Algæ are necessary for the production

of the Lichen, and still more strange that in nature these various Algæ occur without any further result; 3, because many forms of gonidia are not known to Algologists as such, because they have never been seen in a free state; 4, because the Lichen gonidia correspond in their forms only to those Algæ which reproduce themselves by division and not to those which propagate by sexual reproduction, the former process being only a physiological one common to many or all lower vegetable cells, and destitute of systematic value. The transformation of gonidia into zoöspores, "Schwärmzellen," observed by Famintzin and others, is regarded as a process also common to low vegetable cells. The so-called "asynthetic gonidia," i. e., those which occur without the thallus, are, he thinks, not algæ, but free lichen-gonidia. Thirdly, he maintains that lichens are not evidences of parasitism, because the gonidia are in no way debilitated, diseased, or destroyed by their contact with the hyphæ, but on the contrary derive from it nourishment and growth, and if this view were accepted, there would result, as Th. Fries had already observed, in Lichenographia Scandinavia, p. 8, an incredible double and mutual parasitism of hyphæ upon gonidia and of gonidia upon hyphæ.

In conclusion, Dr. Koerber gives his own views in regard to the anatomy of Lichens. He agrees with Schwendener that the gonidia are not produced from the hyphæ of the thallus, but regards the connection of the two as a simple process of nourishment. To account for the origin of the thallus he supposes that the hyphæ of a germinating spore need, for their perfect development, to come in contact with the form of gonidia belonging to their own species. He asserts that the spores of some Lichens, as in the genus *Sphæromphale*, which has muriform spores, do not produce hyphæ, but gonidia of the kind called microgonidia or leptogonidia; and finally suggests several different methods, according to which, in his opinion, the lichen thallus may be produced by asynthetic gonidia (soredia).

Dr. Krempelhüber, in a notice of this essay in *Flora* for March 11, observes that Koerber's hypothesis has not much better foundation than Schwendener's, with which it has much in common. If the observations in regard to the spores of species of *Sphæromphale* are confirmed, he thinks them against Schwendener; and that, if Koerber's arguments and observations are not conclusive against Schwendener's hypothesis, they tend to render it still more improbable.

On the other hand, in *Flora* for March 21, 1875, Dr. George Winter, in a paper entitled "Zur Anatomie einiger Krustenflechten" (On the Anatomy of some Crustaceous Lichens), disputes the assertion that some lichens are destitute of hyphæ, and gives the result of his investigations of *Secoliga abstrusa*, *Sarcogyne privigna*, *Hymenelia affinis*, and *Naetrocymbe fuliginea* (which last he maintains is a Sphæriaceous fungus), and concludes that these Lichens possess undoubted hyphæ, differing in no respect from those of other Ascomycetæ, and that his observations go to confirm Schwendener's theory. His investigations are to be continued. H. W.

Gustave Thuret died suddenly of angina pectoris, on the 10th y, at his residence at Antibes, in the South of France. dge that he had reached the age of about 65 years. He was the best investigators of *Algæ*, and the discoverer of their idia in the *Fuci*, as well as of their phenomena of fertiliza- His earliest papers were published in 1840; the most im- t ones followed a few years later. His researches were kept :he last, and much was still expected from him, although he ow to publish, being extremely conscientious and critical. ;ht also to be commemorated for his services to horticulture. ırden which he established upon his grounds in the vicinity ibes is most remarkable. Perhaps no public collection has ter number of species growing in the open air; it is certainly ılled in *xerophilous* plants,—to use the name recently l by DeCandolle to those which affect arid regions. A) this collection at the proper season, under the genial and plished founder's guidance, was a treat long to be remem- The loss by M. Thuret's unexpected decease is most ;. A. G.

An Inquiry Respecting the Reversion of "Thoroughbred" stic Animals; by WILLIAM H. BREWER of New Haven, (From the Proceedings of the American Association for dvancement of Science, Hartford meeting, 1874.)—* * * not try to prove (what all will admit) that in our most ıted breeds, their special excellences are the accumu- improvement of many successive generations, and that this ,ement is often accompanied with marked and important ;s of form and structure. Now, as this improvement and ; are unquestionably the results of man's care, it is often that if the care be withdrawn, then the breed will retrace ps, and go down by the same road that it came up (only faster, the downhill road being the easier travelled), and e again what it sprang from, or to use the more familiar s which are supposed to sound more scientific, it "*reverts*" *turns to the original type.*" This has been said so often that ;lieved, and with a great class of scientific men has become na, and as such is used to sustain certain theories regarding rmanence of "original types," and the fleeting nature of ired characters." As a dogma, it finds a place in the lec- ıf eminent scientific men, and also in our scientific literature, the papers read before our learned societies, and from these uthorities it spreads and descends through various channels ıt last it is proclaimed by the popular lecturer or finds a ;nt in the "agricultural column" of religious weeklies. * * he last meeting of this association, this dogma of reversion ·ongly insisted on in one of the papers, and I find on p. B, the last volume of its "Proceedings," this: "The hog has ·eatly changed by domestication, and yet, when left to him- ; soon returns to the original type. During the late war

some of the most improved breeds were turned loose and left to shift for themselves. *Three years after, I found them possessing all the physical characters of the wild boar of Europe.*" I have *italicized* in the quotation the special point to which I wish to call attention. At the reading of this paper the author verbally stated that a similar fact had been observed with "Durham cattle." About the same time the same dogma was strongly and publicly affirmed by another scientific authority who is even more eminent. In both cases the dogma was used as an argument to sustain a certain scientific hypothesis, or else to combat another hypothesis.

Now let us turn to another meeting, held scarcely a month after our last one. A herd of short-horns was to be sold at New York Mills, and stock-breeders flocked from near and far to attend this other meeting. They came from England, they came from California, they came from half the States of the Union; they even came from the very regions where these scientific authorities had but just told them that short-horns were so prone to return to their original type. There was less talk at that meeting than at the scientific one; the speeches were in fact *very* short, but they were to the point. The principal speaker was the auctioneer. He was doubtless eloquent in his way, but his eloquence alone will hardly explain the result; for in thirty minutes from the time he began, the sales amounted to a quarter of a million of dollars, and in a very short time, those reckless men, unheeding the warnings of their scientific brethren, bought one hundred and nine head of cattle for $382,000, an average of more than $3,500 per head. For the best five cows (belonging to a particularly excellent strain called the "Dutchess") they paid an average of $31,640 per head. *These prices indicate the faith of those men in the future permanence of the acquired characters of that herd.*

For some years I have been looking for the proof of the oft-repeated assertion, that thoroughbred stock of old and well established breeds ever returns to the original type (whatever that may mean), *under any conditions or circumstances.* Thus far the results have been entirely negative, that is, I often hear the general assertion, but I have not yet found the proof in scientific cases. Until within the past year, however, my inquiries have been verbal, as I had opportunity, and I kept no record of the answers received, because I thought that among practical men (so-called) the thing was settled. But the confident assertions within a year, by eminent authorities, that *such reversions would always take place under certain conditions*, and then, following so closely on the heels of these assertions, the remarkable sale of which I have spoken, have awakened a new interest in the subject, and I have resumed the inquiry, in the hope that, if there be any such great law, we may somewhere find the proof in specific examples. * *

I have therefore prepared the circular which follows, and I ask of the members any aid they may be able to give.

I append a copy of the circular, and I propose to give this association the further results of the inquiry at some future meeting.

"*Dear sir:* Will you have the kindness and patience to answer me the following questions:

1st. Have you personally, ever known any case where *thoroughbred* short-horn cattle, because of climate, poor feed, neglect, or any other cause, have become in character anything else than short-horns—in other words, *where from any cause thoroughbred short-horns have degenerated into animals of any other breed or type?*

2d. Do you personally know of *thoroughbred* animals of any other breeds so changing or "reverting?"

3d. Have you ever heard of such a thing taking place in the experience of other breeders, so well authenticated that you believed it to be a fact?

Now please let me explain why I trespass on your time and good nature with questions that may seem to you to be simply absurd.

I think that the practical breeders of thoroughbred stock (of whatever kind) commonly believe that so long as the breed is kept pure and no other blood mingled, that although the animals may vary greatly in excellence, all of them will have the essential characters which distinguish that breed from all other breeds or "types."

On the other hand, many persons (who are not breeders of thoroughbred stock so far as I know) have asserted that if neglected, any breed will "revert to the original type," or by other words or phrases have carried the idea that, under such or other circumstances, the breed will not only lose its better qualities, but, moreover, that the animals will become of some *other breed or type* which is said to be that of the early and cruder ancestors from which the breed originally sprung, however long ago that may be. * * * * * *

That *grade* animals often "revert," that curious freaks and "sports" often attend violent crossing (and also that breeds *deteriorate* under bad management or bad conditions), are well enough known, but these facts do not effect the specific questions asked where *the blood is supposed to be kept strictly pure.*

18. *Seventh Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri*, made to the State Board of Agriculture; by Charles V. Riley, State Entomologist.—This is a very sensible report, by one of the best entomologists of the country. It gives a large amount of valuable information about various noxious insects of Missouri, and other parts of the country, and advice as to the best means of checking their ravages. Among the insects treated of, the first noticed is the Colorado potato beetle, which, the Report says, originally fed on the *Solanum rostratum* Dunal, of the Rocky Mountains, but had in 1859 reached a point 100 miles west of Omaha; in 1861 invaded Iowa and Southwest Wisconsin; in 1864, 1865 crossed the Mississippi to Western Illinois; in 1866 occupied the region west of a line from Chicago to St. Louis; in 1867 reached Southwest Michigan and

West Indiana; in 1868 had entered Ohio, and in 1874 arrived on the borders of the Atlantic at many points. Another insect treated of is the Chinch-bug (*Micropus leucopterus* Say), which attacks the grains and grasses, whose ravages among the wheat, and corn, and oats of Missouri in 1874 caused a loss to the State, according to the author, of *nineteen millions of dollars.* A third kind is the Rocky Mountain locust (*Caloptenus spretus* Thomas), which has been recently so destructive; and others are the *Philoxera*, the enemy of the grape vine, the *Chrysobothris femorata*, an apple-tree borer, and *canker worms.* The articles are illustrated by excellent figures, and a map shows the path of the locust invasion of 1874 over Missouri.

III. Astronomy.

1. *The Transit of Venus, Dec.* 8, 1874.—In vol. ix of this Journal, at pages 157 and 234, has been given a synopsis of the principal stations at which successful observations of the late transit of Venus had been reported. As these reports for the Southern hemisphere were quite incomplete. we now present a fuller report from the principal stations of the Southern hemisphere. The stations are arranged in the order of latitude.

1. *Observations of the Transit in the Southern Hemisphere.*

(1.) Rodrigues, lat. 19° 4′, long. 4^h 14^m E. English station. Ingress and egress were well observed, and 441 photographic pictures were obtained.

(2.) Mauritius, lat. 20° 20′, long. 3^h 51^m E. Lord Lindsay's station. All the contacts were observed except the first, and 110 good photographs were taken.

(3.) Reunion, lat. 20° 51′, lat. 3^h 42^m E. Dutch station. Third contact observed, and a few photographs taken.

(4.) New Caledonia, lat. 21°, long. 11^h E. French station. All the contacts were observed except the third, and 100 good photographs were taken.

(5.) Windsor, lat. 33° 36′, long. 10^h 4^m E. English observatory The four contacts all observed.

(6.) Sidney, lat. 33° 51′, long. 10^h 5^m E. English observatory. Weather favorable. The four contacts were all observed, and 180 photographs taken.

(7.) Cape of Good Hope, lat. 33° 56′, long. 1^h 14^m E. English observatory. Both contacts at egress observed, and photographs taken.

(8.) Adelaide, lat. 34° 40′, long. 9^h 15^m E. English observatory. Last two contacts were well observed.

(9.) Melbourne, lat. 37° 49′, long. 9^h 40^m E. English observatory. All the contacts were observed except the first external, and 200 photographs were taken.

(10.) St. Paul Island, lat. 38° 43′, long. 5^h 10^m E. French station. Both the internal contacts were observed, and numerous photographs were obtained.

(11.) Campbelltown, Tasmania, lat. 41° 55′, long. 9^h 50^m E. American station. The second internal contact observed, and fifty-five good photographs were taken.

(12.) Hobart-town, Tasmania, lat. 43° 0′, long. 9^h 49^m E. American station. Thirty-nine good photographs were obtained, but no contacts were observed.

(13.) Christ Church, New Zealand, lat. 43° 30′, long. 11^h 31^m E. English station. Observations failed from clouds.

(14.) Chatham Island, lat. 43° 48′, long. 12^h 12^m E. American station. No contacts observed. Eight good photographs taken.

(15.) Queenstown, New Zealand, lat. 45° 0′, long. 11^h 15^m E. American station. First and second external contacts observed. Fifty-nine good photographs taken.

(16.) Kerguelen Islands, lat. 49° 54′, long. 5^h 41^m E. English, German, and American station. The Germans got both contacts at ingress and egress. The English and Americans observed the ingress, but not the egress. Twenty-six good photographs were taken by the American party.

(17.) Auckland Islands, lat. 50° 48′, long. 11^h 7^m E. German station. The sun was obscured till ten minutes after the beginning of the transit. From that time, the contacts were observed, and heliometer observations and photographs were obtained.

(18.) Campbell Island, lat. 52° 33′, long. 11^h 17^m E. French station. Venus seen before ingress only. No contacts observed.

2. *First results from the Transit.*

M. Puiseux has given the first French results for the sun's parallax, using the observations of Pekin and St. Paul, all made with object glasses of 216 millimeters ($8\frac{1}{2}$ English inches). The parallax is 8″·879. E. L.

2. *On the Solar structure;* by FATHER SECCHI.—Father Secchi has made a very full reply to the article by Professor Langley, "on the comparison of theories of solar structure with observation," published in the March number of this Journal, first by notes upon the communication as it appeared in the *Memorie degli Spectroscopisti* of Palermo, and in a lecture delivered to the Tiberine Academy, which was published in the *Voce della Verita*, which has been in part reproduced by him in a subsequent number of the *Memorie*, with additional remarks.

Father Secchi accepts, without reserve, the statements of the article in question so far as they embody facts of observation, and remarks, of the illustration, that it is the very truth, rendered in minute detail. As to the interpretation of fact, there is, however, he observes, more than one point of view, and this leads him to an exposition of his own. His views, as now presented, differ from those he was understood to hold till lately, and in their present form are of such interest that their outlines are here reproduced, as nearly in his own terms as is possible in such an abridgement.

Spots are due to eruptions of metallic vapors from the interior of the sun.—Three phases in the life of a spot may be distin-

guished: (1) That of its formation. (2) That of a subsequent period of relative calm. (3.) That of its closure and extinction. In the first the metallic eruptions attain their maximum violence; vertical motion on an enormous scale is visible both in the photosphere and in the chromosphere; in the former (to borrow an architectural term) *in plan*, in the latter *in elevation*. These vertical motions are a consequence, not a cause—products of the eruption, admittedly associated with the spot, but not generators of it. (It is this period which Mr. Langley has taken as the subject of his article, as shown by a history of the spots' appearance in the clear sky of Rome, in the days preceding and following those employed in its study at Allegheny.)

In the second phase the spot commonly presents a crater-like formation, an obscure central mass being invaded by convergent gaseous streams, which form the luminous bridges and filaments. The eruption now is comparatively gentle, or has nearly ceased, though new matter, still extruded, checks the invasion of the surrounding photosphere, and mingling with its insetting currents, causes the radiate appearance of the penumbra. This phase may be compared to that period in the eruption of the terrestrial volcano when the lava, which has risen to the tip of the crater, is being discharged without tumultuous outbursts, or the formation of the *pine* of smoke.

In the third phase, both of the terrestrial and solar volcano, the emission ceases and all is over.

We may now understand how it is that though every great eruption generates a spot, every spot is not seen accompanied by a chromospheric eruption. To the second and third epochs alone belong that condition of the nucleus, as a deposit of more or less stagnant matter, which Mr. Langley mistakingly assumes Father Secchi to suppose it to be in, generally. M. Faye and he have attacked Father Secchi from opposite sides, not perceiving that the latter's point of view is double—as it is. More than this (and however such critics may exclaim against the apparent contradiction), he affirms the possibility of a third thing, a sequence to Galileo's and Kirchoff's views, namely, that a spot may be generated from a cloud of metallic vapors above the photosphere, or resting on and partly immersed in it; it being by no means certain that the spot is always a cavity. Let us not impose our own artificial limits on greatly varied Nature!

P. Secchi concludes that Mr. Langley's observations, though undoubtedly exact and reliable, give little which he has not himself, in considerable part, anticipated, though they may be admitted to have carried the resolution of photospheric detail farther in some respects than he has been able to do, with the smaller aperture of the Roman instrument.

Mr. Langley's impression that the observations he brings do not accord well with Father Secchi's views, is altogether owing to misapprehension of the true nature of these; on the contrary, the article and illustration bring gratifying and remarkable confirma-

tion of Father Secchi's own observations, and on points where they have been called in question.

On the whole, then, while he must insist that longer study will modify the American observer's interpretation of the facts, he would rather be understood as admiring the Allegheny observations than as disputing them. x.

3. *Observations on Magnetic Declination made at the Trevandrum and Augustia Observatories.* Vol. I. Discussed and edited by JOHN ALLEN BROUN. London, 1874.—This volume is the first of the official publications of the extensive series of observations made since 1836, at Trevandrum, under the successive superintendencies of Mr. J. Caldecott and Mr. J. A. Broun. In it the author gives us the first installment of a series of volumes of magnetic observations made at the auxiliary observatory at Augustia, and the main establishment at Trevandrum during the years 1852 to 1869. In explanation of the latter date, it may be stated that although Mr. Broun departed from Trevandrum in April, 1865, yet he was so fortunate as to obtain the continuation for six years of the series of observations made by his two best assistants. He has himself, for the past ten years, therefore, resided in London, and superintended the discussion and editing of the series of volumes which are promised to the scientific world. In the present volume we have a *resumé* of most of the publications made by him during the past 30 years in the transactions of various scientific societies, which appear here as contributions to terrestrial magnetism from the Trevandrum Observatory. Pages 1 to 80 consist especially of descriptions of instruments, methods of observation and reduction, and narratives of the various explorations made into the neighboring country. Pages 80 to 184 give us the results of magnetic observations made with the improved instruments introduced by Mr. Broun, giving in fact a full, and often a new, discussion thereof, that adds materially to our knowledge of questions relating to the variations of magnetic declination. The chapter relating to the 26-day period, co-extensive with the rotation of the sun on its axis, is interesting, inasmuch as the author states that he has evidence, to be given at a future time, of a double oscillation of this period. Pages 192 to 448 give the individual hourly observations for every day of the year, with the declinometers established at Trevandrum, Augustia, Shertally, and Cape Comorin. Pages 453 to 570 are occupied with appendices, principally the annual reports of the director in reference to the observatories, the almanac, the public museum and other public duties which were imposed upon him.

The observatory at Trevandrum occupies the summit of a small hill, which is from 60 to 70 feet above the sea and within four miles of the shore. The observatory at Augustia was intended to be built at as great a height as possible, and at the same time as near as possible to the Trevandrum Observatory. Its altitude is accordingly found to be about 6,200 feet, and it is situated about 10 miles from the main station. The stations at Shertally and

Cape Comorin were occupied for a few months only in 1858 and 1859.

The appendices containing Mr. Broun's annual reports are very interesting reading, if for no other reason than as showing the tenacity with which he clung to his determination to carry out a series of most exact scientific observations in a region known only to a few savages and inhabited by ferocious animals. Every page gives us illustrations of the difficulties that he had to encounter both from the climate and the native assistants, and makes us wonder that he has accomplished so much. He certainly would not have been able to have accomplished what he has done had not his previous experience at the Makerstoun Observatory stood him in good stead. C. A.

4. *Determination of weights to be given to observations for determining time with portable transit instruments, recorded by the chronographic method;* by Charles A. Schott. Appendix No. 12, U. S. Coast Survey Report for 1872.—In this little pamphlet Mr. Schott collects together the results of the general experience of the telegraph longitude parties of the Coast Survey for a number of years. He states that the introduction of the chronographer registration of transit of stars has considerably increased their precision, rendering it desirable to discuss the relative weights of the equations of condition. In the Coast Survey practice, two classes of portable instruments are employed for longitude purposes, the largest size having reticules of 25 threads, the smaller size having glass diaphragms of 15 lines. It appears from the probable errors deduced in Mr. Schott's paper, that for the larger instruments the gain in accuracy, between 17 and 25 threads, is very trifling, and probably more than counterbalanced by the increased fatigue of the observer, and consequent change in his personal errors; a diaphragm of 17 threads is recommended, which may be conveniently disposed in three tallies. The probable error of a transit over a single thread is found to be

for large portable transits $\pm\sqrt{(60\cdot063)^2+(0\cdot036)^2\tan^2\delta}$.
for small " " $\pm\sqrt{(0\cdot080)^2+(0\cdot063)^2\tan^2\delta}$.

In the reduction of the observations made during any one night for longitude purposes, it is recommended not to assume a constant azimuthal error, but to determine it before and after each reversal of the instrument. In general, the collimation, azimuth and clock correction should be determined independently, before and after each reversal. The criterion for the correctness of the entire work is found in the equality of the clock corrections as referred to the same moment of time. C. A.

5. *On the Meteorite of Lancé;* by Dr. K. von Drasche; Tschermak's Mineralogische Mittheilungen, 1875.—This meteorite fell near Lancé in July, 1872; it belongs to Rose's group called Chondrites. Dr. Drasche has given the results of a minute and careful microscopic examination.

III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the Height of the St. Louis Directrix;* by G. C. BROADHEAD. (From a letter to one of the Editors.)—I find that Mr. J. T. Gardner, in his determination of the height of the St. Louis directrix,* has omitted all reference to the careful observations of Dr. Engelmann, as given in vol. i, No. 4 of the Transactions of the Academy of Science of St. Louis (pp. 663–667), and quoted in the American Journal of Science, vol. xxx, p. 394 (1860). Humphreys and Abbot, in their work, bear testimony to the correctness of the observations of Dr. Engelmann. Dr. Engelmann and Mr. E. H. Barton, of New Orleans, carefully adjusted two barometers, compared them together, and then observed them for several months, one party being in St. Louis and the other in New Orleans. The result proved the elevation of the St. Louis directrix to be 404·9 feet above the Gulf. Mr. Gardner makes it 428·29 feet, a difference of 23·39 feet. Mr. Gardner's results are chiefly or altogether based on railroad levels. Now, if these railroad levels were run continuously from the Gulf up, they might be correct. But I have had much to do with getting railroad profiles, and have found that few of them can be relied on throughout. I have two profiles of one railroad 300 miles long in Missouri, and they widely differ; and one of these, the Missouri Pacific, claims to be correct. The profile notes of the Missouri, Kansas and Texas Railroad, from Texas to Sedalia, makes out a different elevation above the sea at Sedalia from those of the Missouri Pacific Railroad. There is not a railroad line in Missouri north of the Missouri River whose elevations can be relied on throughout. One railroad, of 150 miles long, has three or four breaks of elevations on it, each beginning at an assumed datum.

2. *Swedish Arctic Explorations.*—The Swedish Arctic Expedition to Novaya Zemlya, which will start at the beginning of next month from Tromsöe, will be occupied first with botanical, geological, and ethnological inquiries in the southern part of Novaya Zemlya, and then advance along the west coast to the northern point, which it expects to reach about the middle of August. Thence it will go to the northeast to explore this still quite unknown part of the Polar Sea, and then southward to the mouths of the Obi and the Jenisei, where the country is geologically very interesting. If the ice creates no obstacles, Prof. Nordenskiöld will here quit the vessel, and go in a boat up the river, to return home afterward by land.—*Nature*, May 20.

3. *Norwegian Exploration.*—The Norwegian Government has granted a credit of £4,000 for an expedition to be sent out next year under the scientific direction of Dr. Mohn, for the exploration of the sea between Iceland, the Faroe Islands, Spitzbergen, and Jan Mayen. The commander of this expedition will be Capt. Carr Wile, of the Royal Norwegian Navy, who is now in England gathering information as to the work done by the *Challenger.*—*Nature*, June 10.

* See this Journal, III, vol. ix, p. 309.

4. *British Arctic Expedition.*—The ships Alert and Discovery of the British Arctic Expedition, sailed from Portsmouth on the afternoon of the 29th of May. The Valorous accompanies them to Disco.

5. *American Association for the Advancement of Science.*—The next meeting of the American Association will be held at Detroit, Michigan, in August, commencing on Wednesday, the 11th, at 10 o'clock, A. M. The headquarters of the association will be at the Russell House on Monday and Tuesday, and afterward at the City Hall and Court House, directly opposite. That the circular of the Local Committee may be received without fail by those intending to be present, word should be sent by each to Frederick Woolfenden, Esq., Detroit, Secretary of the committee. It is expected that the Chemical Sub-section, instituted at the last meeting, will be largely represented; and also, that the departments of Ethnology and Archæology will have a prominent sub-section established, to be called the sub-section of Anthropology. The president of the year is Mr. J. E. Hilgard, of the Coast Survey; the vice-presidents, Prof. H. A. Newton of New Haven for Section A, and Dr. J. W. Dawson of Montreal for Section B. Prof. S. W. Johnson of New Haven is chairman of the Chemical Sub-section.

The new volume of the Proceedings of the Association—that for 1874—has been issued. The volumes of the Proceedings, now twenty-three in number, can be obtained from the Permanent Secretary, F. W. Putnam, Salem, Mass., at the price of $1.50 a volume; or, if ten or more volumes are ordered, for $1.00 a volume.

6. *Milligrade Thermometric Scale.*—Mr. J. Williams, in a paper before the Chemical Society of London, proposes to substitute the freezing and boiling point of mercury for those of water, and to divide the scale into a thousand parts.

7. *Dr. Horace Wells.*—A bronze statue to Dr. Horace Wells of Hartford, Connecticut, "the discoverer of Anæsthesia," who died nearly a quarter of a century since, will soon be erected in Hartford. The statue is by the sculptor, Truman H. Bartlett. The State of Connecticut appropriated five thousand dollars toward the monument, and the city of Hartford an equal amount. The expenses of the pedestal of the statue, which should also be of bronze, are not met by these appropriations, and funds are solicited of the public by the Committee of the Hartford Medical Society, of whom Dr. E. H. Hunt of Hartford is chairman, and Dr. G. W. Russell of the same city treasurer. Dr. Wells was the world's benefactor.

8. *Report of the Superintendent of the Coast Survey for the year* 1871. 220 pp. 4to, with many maps.—Besides the general report on the progress of the survey, this volume contains a paper by G. Davidson and C. A. Schott, Assistants, on a comparison of the methods of determining heights by means of leveling, vertical angle and barometric measures from observations in California; reports by Assistants G. W. Dean and C. H. F. Peters, of obser

vations of the total solar eclipse of Dec. 22, 1870; a report by C. A. Schott on the adaptation of triangulations to the various conditions of configuration and character of the surface of country and other causes; description, by J. Homer Lane, of a new form of mercurial horizon, in which vibrations are speedily extinguished. There is also a *General Index of professional and scientific papers contained in the Coast Survey Reports from* 1851 to 1870. The volume contains 36 large charts, and among these, under the head of River and Harbor Charts, there are charts of Plattsburgh, Burlington, New Haven, New York Bay and Harbor, Nos. 1 and 2, Delaware River from Navy Yard to Fort Mifflin Light-house, Neuse River, Passes of the Mississippi, Puget Sound.

9. *The Life and Growth of Language: an Outline of Linguistic Science*; by W. D. Whitney, Professor of Sanskrit and Comparative Philology in Yale College. 326 pp. 12mo. New York, 1875. (D. Appleton & Co.)—Prof. Whitney writes with the clearness, depth of insight and comprehensiveness of one who has full command of his subject in all its bearings and details. His word is an admirable exposition in a brief form of the science, growth, and, as far as can be reasoned out from known facts, the origin, of language.

10. *The Recent Origin of Man, illustrated by Geology and the Modern Science of prehistoric Archæology*; by James C. Southall. 606 pp. 8vo, with many illustrations. Philadelphia, 1875. (J. B. Lippincott & Co.)—The author of this work has gathered into it a large amount of information on prehistoric man, and on the valley-formations, cave deposits, and other repositories of human relics. The attempts which have been made to measure time by means of the thickness of valley-formations, peat-beds and stalagmitic deposits are discussed, and sources of error pointed out; and the conclusion reached is that indicated in the title of the work. The facts are given with much detail and are illustrated by many figures. Unfortunately the author lacks in scientific knowledge, and therefore in ability to handle well the geological questions he deals with, and steer clear of his prejudices. His chapter on the fickleness of science shows great misapprehension of the subject. In fact, the whole work exhibits a temper toward scientific writers, and a consequent misunderstanding of men and opinions, which is calculated to repel any honest searcher for truth who is not already of the author's mind.

11. *Note sur les Tremblements de Terre en* 1871, *avec Suppléments pour les années antérieures, de* 1843 *a* 1871; par M. Alexis Perrey, Professeur Honoraire a la Faculté des Sciences de Dijon. pp. 145. Bruxelles, 1875.—This constitutes Professor Perrey's twenty-ninth annual report presented to the Royal Academy of Belgium and is published in vol. xxiv of their *Memoires*. The first seventy-two pages are occupied with the supplementary report for the preceding years. In the remainder, constituting the report for 1871, the most noteworthy items are: Earthquakes in England, March 17; in Chili, March 25; in the Philippine Islands, May 1; and the eruption of Mauna Loa in August.

Étude du réseau pentagonal dans l'océan Pacifique, pp. 4, and *Sur les volcans de l'île de Java, et leurs rapports avec le réseau pentagonal*, pp. 3; par M. ALEXIS PERREY.—Two interesting and valuable papers presented to the Academie des Sciences at Paris on August 17 and November 9, 1874. C. G. R.

12. *Storms: their Nature, Classification and Laws, with the means of predicting them by their embodiments, the Clouds*; by WM. BLASIUS, formerly Professor of the Natural Sciences in the Lyceum of Hanover. 342 pp. 8vo. Philadelphia, 1875. (Porter and Coates.)—The author observes in his Preface: "I am convinced that the existing theories of the nature and laws of changes of weather are intrinsically erroneous, and that at least a much nearer approximation to the truth will be found in this volume."

13. *Climate and Time in their Geological Relations: a theory of Secular Changes of the Earth's Climate*; by JAMES CROLL, Geological Survey of Scotland. 578 pp. 8vo, with many illustrations. London. 1875. (Daldy, Isbister & Co.)—This work is a learned controversial discussion of some of the most difficult questions in geology and terrestrial physics, viz: the source of oceanic currents; the origin of changes of climate and the glacial epochs in geological history; the probable age and origin of the sun; a method of determining the mean thickness of the earth's sedimentary rocks; cause of the changing water-level in the earlier half of the Quaternary; the effect on climate of a change in the obliquity of the ecliptic; theories of glacier-motion and explanations of many glacial phenomena; nature of heat vibrations; the cause of regelation, and many other related topics. It is illustrated by several plates.

14. *English Men of Science, their Nature and Nurture*; by FRANCIS GALTON, F.R.S., author of Hereditary Genius, &c. 206 pp. 12mo. London, 1875. (New York, D. Appleton & Co.)—This work, already well known, is a valuable contribution to the subject of heredity, as well as to that of the history of science.

15. *The Aerial World. A popular account of the phenomena and life of the Atmosphere*; by G. HARTWIG, M. and P.D. 556 pp. with numerous illustrations. New York, 1875. (D. Appleton & Co.)—A popular and handsome work, full of interesting matter and for the most part good in its science.

16. *French Academy of Sciences.*—General Sabine has been elected a corresponding member of the Academy of Sciences.

OBITUARY.

JOHN EDWARD GRAY.—This veteran naturalist died on the 7th of April, at the residence in the British Museum which he has long occupied, and which, having recently retired from the keepership, he was about to vacate. Naturalists from all parts of the world have pleasant memories of the liberal but unostentatious hospitality there dispensed by Dr. Gray and his surviving consort, and will miss him at the Museum, which he has served most assiduously and ably for more than half a century. He was

Dr. Leach's assistant almost in boyhood, was officially connected with the Museum in 1824, when Mr. Children became keeper of the Natural History collections, and succeeded to the keepership of the Zoological collections in 1840, upon Mr. Children's retirement. The whole development of this noble collection has therefore taken place under Dr. Gray's superintendence. To it he brought a persistent ardor, indomitable energies, and great practical powers; and he worked unflaggingly down nearly to the close of the year 1869, when he was suddenly prostrated by paralysis. Even then his mental activity was hardly or briefly interrupted, although he lost the use of his right side, and his scientific contributions have continued to appear down even to the beginning of the present year. As some evidence of his activity, it may be mentioned that his contributions to scientific journals and transactions alone—as indexed in the Royal Society's Catalogue, had reached 500 in number in 1863, and his independent publications, before and since that date, are far from few. He published also upon penny postage and postage stamps, decimal coinage, prison discipline, sanitary reforms, the arrangement and utilization of museums, and many other topics. These were the bye-plays or recreations of a busy life; but he was pre-eminently a zoologist,—a typical zoologist of "the old Linnean school," and the last of the race. The biographical notices in the various English journals, most of them familiar to our readers, give good general views of the amount and character of his zoological work. He was also a botanist, and it was in this field that he entered upon his scientific career. In this department he was not of the Linnean school. For he wrote "the systematic part of the 'Natural Arrangement of British Plants,' the work that first introduced the natural system of plants to the student of English history." Although published in the name of his father, Samuel Frederic Gray, the son reclaimed it as his own, stating that he was responsible for all but the introductory portion. It was a very elaborate work for a young man, and several hands were probably engaged in it. But it failed of success, partly because it was not very well thought of by the leading botanists of Jussiæan school, and partly on account of a pitiful personal opposition on the part of the Linnæans, who subjected the young reformer "to something very like persecution." If Dr. Gray was "over-given to controversy," perhaps this early ill-treatment may have fostered the disposition. When the Royal Botanical Society of London, which established the exhibitions and conservatories in Hyde Park, was founded, Dr. Gray accepted the presidency. In 1864 he published a neat little Handbook of British Water-weeds or Algæ. In 1865 he caused to be printed—as a matter of historical interest—a portion of Salisbury's manuscript "Genera of Plants" (pp. 143, 8vo, Van Voorst), which, with other MSS. and papers, was made over to him by Mr. Burchell's executor, after the death of the latter in 1864. Salisbury had bequeathed all his papers to Burchell, who made no use of them. Dr. Gray's in-

terest in reclaiming them, and in arranging for their preservation in the British Museum, grew out of memory of assistance rendered by Salisbury, who lent him these manuscripts when he was preparing the "Natural Arrangement of British Plants," and of former propositions of Salisbury, that he should devote himself to botany and edit any unpublished works that the latter might leave in manuscript. Dr. Gray declined the proposition, and with it tempting pecuniary offers. But, after forty years interval, he printed a "fragment of the Genera Plantarum, exactly as it was left by the author, for the purpose of showing the kind of work that he intended to produce."

Dr. Gray married, in 1826, the widow of his cousin, Francis Edward Gray, "a fitting helpmate to share and encourage him in all his undertakings," an excellent algologist and conchologist, a lady of remarkable powers and graces. A. G.

ADMIRAL SHERARD OSBORN died on the 6th of May, in his 54th year. He entered the Royal navy in 1837, became lieutenant in 1846, and three years afterward was selected as a volunteer for the Arctic expedition sent in search of Sir John Franklin: again, in 1852, he took command of the Pioneer on a second extended Arctic expedition, having the same purpose in view. He was a member of the committee on equipments of the expedition which has just sailed.

SAMUEL HEINRICH SCHWABE, the astronomer, died on the 11th of April, in his 86th year. To Schwabe's observations on the sun's spots science owes the discovery of their periodicity, and that the length of the period was ten to eleven years.

A. G. FINDLAY, the geographer, and member of the Council of the Geographical Society of London, died at Dover on the 3d of May, in his 64th year.

M. DESHAYES, Professor in the Paris Museum of Natural History, died on the 9th of June.

JOSEPH WINLOCK, Director of the Observatory of Harvard College, died suddenly on the 11th of June.

Sir WILLIAM LOGAN, long at the head of the Geological Survey of Canada, died at Ontario, Canada, on the 28th of June.

Memoirs of the Geological Survey of India. Palæontologiæ Indicæ. Fauna of the Indian Fluviatile Deposits, vol. i, ser. x; I, Rhinoceros Deccanensis, by R. B. FOOTE, 18 pp., fol, with three plates.—Also vol. x, part 2, and vol. xi, pt. 1 of the Memoirs, and vol vii. Parts 1 to 4 of the "Records" of the Survey.

Practical Hints on the selection and use of the Microscope, by John Phin. 131 pp. 12mo. 1875. New York. (The Industrial Publication Co.)—A small meager work, very inadequately illustrated.

A Brief Essay on Heat, Light, Electricity and Magnetism, by Charles Skelton, M.D. 75 pp. 8vo. Trenton, New Jersey, 1875.—The author, objecting to the present theories, makes light the rapid wave motion of imponderable matter; heat, this matter in excess in ponderable matter: electricity and magnetism, this imponderable matter in flowing currents.

Die Idee der Entwickelung; eine sozial philosophische Darstellung; von Leopold Jacoby. Erster Theil, 134 pp. 8vo. Berlin, 1874. (H. E. Oliven.)

What Young People should Know. The Reproductive function in Man and the lower animals; by Burt G. Wilder. 212 pp. 12mo, with 26 illustrations. Boston, 1875. (Estes and Lauriat.)

THE

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[THIRD SERIES.]

ART. XIV. – *Historical Note on the Observation of the Corona and Red Prominences of the Sun;* by EDWARD S. HOLDEN.

So much interest attaches to the phenomena of the corona and red prominences, as observed during total solar eclipses, and correct views of their nature and of the proper means of observing them are so recent, that I feel it proper to give here a brief account of what I believe to be the first attempt to see these, under ordinary conditions, with an uneclipsed sun.* This account is contained in the private diary of the late G. P. Bond, formerly Director of the Observatory of Harvard College, which has become known to me through the kindness of his daughters.

Bond observed the total solar eclipse of July 28th, 1851, at Lilla Edet in Sweden, and his report is published in the Memoirs of the Royal Astronomical Society, vol. xxi, page 97.

From Sweden, Bond went to Geneva, where he arrived in September, 1851, and from this point I may transcribe from his diary, making no changes except the occasional insertion or omission of unimportant words.

"Geneva, Sunday, Sept. 14, 1851.

I think I must go to Chamounix to try whether it may be possible to discern the red flames on the sun's disk by occulting all but the very edge, upon one of the lofty peaks. It

* Airy, Nasmyth, Baden-Powell, Piazzi-Smith and others experimented in this direction, about this time, with various results. See Edinburgh Astr. Obs., vol. xi, p. 279; Mem. R. A. S., vol. xvi, p. 301, etc.

seems to me not altogether impossible. Certainly an experiment worth trying and a new application of the '*Aiguilles*.'
* * * * * * * * * * *

Geneva, Sept. 15, 1851.

* * * The weather looks dark and lowering with an uncomfortable northeast wind, but M. Plantamour thinks it is likely to be fine weather, and on this recommendation I took a place in the diligence for Chamounix. * * * *

Chamounix, Sept. 18, 1851.

Last evening the stars were shining through the opening clouds, giving promise of improving weather, but a glance out of the window, this morning, dispels all such anticipations.
* * * * * * * * * * *

Chamounix, Sept. 19, 1851.

I woke this morning at five and my first impulse was to go to the window to see the signs of the weather. Last night I had hopes of an improvement. But I was surprised to find a clear sky; some clouds were resting round the '*aiguille*,' but the summit of Mt. Blanc was clear. Started for Montanvert at 7.15 with a guide. * * * * * * * *

Mer de Glace.

* * * Attempted two or three times to hide the sun's disk by projecting rocks to try to see the red prominences, but could not get a station far enough off. * * * *

Chamounix, Sept. 20, 1851.

* * * Snowing fast in morning. Weather desperately bad. But before going to bed it was quite clear. * * *

Chamounix, Sept. 21, 1851.

* * * The fine prospects of last night were effectually put aside by another snow storm. * * * * * *

Chamounix, Sept 22, 1851.

The morning bad as usual. * * * * * *

Chamounix, Sept. 23. 1851.

This morning still cloudy, yet the prospect for an improvement was encouraging. Soon after breakfast the sun appeared struggling in the clouds, and I hurried off with a spy-glass not to lose the slightest chance of seeing the phenomena I wished to; * * * I spent two or three hours in the wet fields to no purpose. In the afternoon there was an effort at clearing again.

Chamounix to Martigny, Sept. 24, 1851.

The clouds this morning still hung on the mountains, but overhead there seemed some signs of clear sky. To make sure of losing no chance I took an early breakfast and left for the fields with the ordinary spy-glass belonging to the hotel under my arm. Sometimes it would be almost clear, and then again it began to rain, and I was undecided whether to give up and

start for Martigny or to stay another day. At last I saw the sun's disk and took up my station on the edge of the shadow of the '*Aiguille de Blettière*.' It was still cloudy, but I was satisfied from the nature of the experiment:—

1st. That a very clear air is necessary.

2d. Plenty of time to choose projections, affording views of as large a portion of the circumference of the disk as possible while the rest is hidden.

And lastly, a good achromatic telescope easily moved.

I did not expect to find it so easy an experiment, nor to find a mass so well-fitted for the purpose as the '*Aiguille de Blettière*' which has a smooth edge, inclined, so as to allow the sun to disappear slowly behind it.

The naked eye easily bears a small portion of the sunlight. From 7 to 9¼ I followed the shadow over the valley. It was nearly clear for a few moments before it reached the woods on the side of the mountain, but there were still some light clouds over the sun and nothing could be seen certainly of the corona; the clouds and mist would account for what I did see, and on the other hand, the color of the telescope supplied too much red just at the edge for one to be able to see any of the red flames, if they existed there.

On the whole, I am more than ever sure that the experiment can be made, and I think will be by some one more fortunate than I."

ART. XV.—*Walker's Statistical Atlas of the United States.**

A CENSUS report consists essentially of statistical tables. In these, certain results are stated numerically, and, like other tables of abstract numbers, the generalizations, which often constitute the most important features of their value, can be seen only after long study and calculation, much of which must be performed by each individual inquirer. Moreover, but few persons have the peculiar mathematical and intellectual training necessary to perceive other than the most obvious generalizations when given in that form of detail. Consequently, in the illustration of facts where numerical tables are involved, much study has been expended in devising other methods of

*** Statistical Atlas of the United States, based on the results of the Ninth Census, 1870, with contributions from many eminent men of science and several departments of the Government. Compiled, under authority of Congress, by Francis A. Walker, M.A., Superintendent of the 9th Census, Professor of Political Economy and History, Sheffield Scientific School of Yale College. Julius Bien, Lith. 1874.**

presenting the facts to the mind. In various branches of science, great gain has resulted by representing quantities in other ways than by series of numerals, especially by the use of comparative areas, geometrical figures, curves, shades and colors.

Until our last census, the results have been published in the numerical form only. In these reports, the Superintendent introduced a few plates by which certain generalizations were shown by comparative shadings or geographical maps. Their general value was readily seen and they were received with great favor. In fact, they made the desirability of more maps devoted to further illustration so obvious that Congress directed Professor Walker, the late Superintendent of the census, who had prepared them, to prepare a "Statistical Atlas." Several portions of this work have already been announced in this Journal as the work progressed, and the complete result is now at hand in a large folio Atlas, consisting of 60 plates and about the same number of letter-press pages.

On the plates, all the methods named for graphic illustration have been used. The compiler divides them into two classes, the Geographical and the Geometrical. The former embraces 65 maps, variously shaded, colored or lined, filling 38 sheets. Six of these maps are double-page size (22×30 inches), 25 of full single-page, and 34 of smaller size.

Sixteen full-page plates are occupied by the geometrical illustrations, on which a variety of devices are used and with most excellent effect. Sometimes by comparative areas and colors in squares and rectangles, sometimes by polygons of ingenious but simple construction, sometimes by circles and circular areas, and in a few cases by lineal curves, the whole disposed in 1208 figures.

The letter press is of the same folio size, and besides the title, index and explanatory preface, consists of eleven "memoirs and discussions" of two to nine pages each, prepared by nine authors and mostly upon subjects treated in the plates. They contain also a few cuts.

It is not too much to say that this is one of the most instructive publications ever issued by our government, and yet it is impossible to satisfactorily treat it in any written article. Precisely as a painting cannot be described in words, so these sixty plates cannot be. Any such description will bear about the same relation to the original that a written description of a person (on his passport, for instance) does to his photographic portrait. Sometimes these plates show an arrangement of facts in such a way that their significance may be easily seen by many, whereas if the same facts were merely stated in the usual tabular form they would be understood by but few. Some-

times they exhibit facts that absolutely refuse to be shown by mere numerical tables. In short, as already suggested, the very reason of their being is because words and numbers cannot or will not tell the whole truth.

The principles involved in the construction of the various illustrations are fully discussed in the text or on the plates. Suffice it here to say that ten of the maps are prepared from data not derived from census returns, but which are of special interest in such a work. The shadings of 55 maps and the construction of more than 1,200 figures are based on computations from census data. Some of these computations were very elaborate; in other cases, where simple, the actual labor necessary was very large. For instance, in the preparation of crop maps it is not easy to show at the same time "the importance of the crop to the county, and of the county to the crop of the country." Now the rule adopted, arbitrary to be sure, but perhaps the best yet devised, is as follows: "The number of bushels, bales, tons, or pounds (the unit of quantity appropriate to the special crop) produced in each county is divided, first by the number of inhabitants, and second by the number of acres of improved land in the county; the two quotients thus obtained are multiplied together, and the square root of the product is taken as the measure of the productive power, in respect to that crop, of the county." When we consider that the county is the nominal geographical unit used (this even being subdivided where accuracy of detail seemed to require it), and that there were about 2200 organized counties when the census was taken, we get some idea, vague though it must be, of the vast labor of computation expended in the production of the entire work. It is probable that over 200,000 computations were performed.

The work is divided into three parts. The first, relating to the "Physical Features of the United States," contains ten maps, five of which are double page. The map of the River Systems (by Gen. von Steinwehr) is the best yet published to illustrate the drainage areas. It has, moreover, combined with this, all the more important general facts of population and production as related to those areas. One map is of the "Distribution of Woodlands;" one is "Hypsometric;" two are Geological; and five relate to Climate, three of these by the Signal Service Bureau and two by the Smithsonian. The relations of these maps to each other are particularly instructive. For instance, the relation between woodlands and rainfall and other climatic conditions has of late been the subject of much dogmatic theorizing. A comparison of these maps shows that the forests of Washington Territory (perhaps the heaviest in the world), are in regions having an annual rainfall of 60 inches

and upward. The magnificent forests found from Minnesota to Maine are in regions of 28 to 40 inches, a rainfall precisely identical with that of the nearly treeless prairies which extend westward from Chicago. The northern part of the Michigan peninsula, with its heavy timber, is marked with precisely the same rainfall as large portions of southern Minnesota lying in the same latitude, and nearly treeless. Interrupted prairies extend across Mississippi and Alabama, where we have the heaviest rainfall east of the Sierra Nevada.

Again, compare the woodland map with that of "storm centers" and prevailing winds. The regions of numerous storm centers in northern Michigan, New York and Maine, are heavily timbered; the similar region of eastern Nebraska is almost treeless. A comparison of the regions of more or less winds show similarly diversified facts. While there is undoubtedly a very intimate relation between forests and rainfall when the latter is less than 25 inches annually, where the quantity is above that, certain relations which are zealously claimed to exist, are shown by these maps either to not exist at all, or else that the relative dependence has been vastly overstated. The map of the Coal measures is especially impressive, and we hope to see the excellent map of "Geological formations" struck off in a separate edition for the use of students and travelers.

The five memoirs of this part are by as many authors. On the one hand, they are all too comprehensive to make satisfactory extracts from, and at the same time too condensed to epitomize. The one on "The Physical Features of the United States" (by Prof. J. D. Whitney) is a model of comprehensive condensation. Further notice of this physical part is reserved for another number.

Part 2d, devoted to "Social and Industrial Statistics," contains forty-nine maps, four plates of illustration by geometrical methods, and four memoirs. Two of the memoirs and one map relate to the acquisition, distribution and political division of our territory. Eleven maps show the density and distribution of the population at various periods of our history. One plate and twenty-two maps illustrate the elements of population, nine maps relate to agriculture, six maps and three plates to the distribution of wealth, public indebtedness, taxation, illiteracy, occupation, and church accommodation.

The memoir by Prof. Walker, on the "Progress of the Nation," is the completest in the volume, and is specially illustrated by thirteen maps, eleven of which illustrate density and distribution of population. In his discussion of the subject, a region assumes the dignity of a *settlement* when the census-taker can find a population of two per square mile. The white popula-

tion of a region more sparsely inhabited than that are scarcely permanent enough to be called settlers. He traces the line surrounding such areas, and also of each of the adopted degrees of density. The following table gives some of the more simple features of this calculation.

Date.	Total area of settlement, in square miles.	Population.	Average density of settlement. Persons to a sq. mile.
1790	239,935	3,929,214	16·4
1800	305,708	5,308,483	17·3
1810	407,945	7,239,881	17·7
1820	508,717	9,633,822	18·9
1830	632,717	12,866,020	20·3
1840	807,292	17,069,453	21·1
1850	979,249	23,191,876	23·7
1860	1,194,754	31,443,321	26·5
1870	1,272,239	38,558,371	30·2

It is noticed here that in the 40 years following 1790, the area of settlements increased 163 per cent, and the density 24 per cent, while in the next 40 years the area increased 101 per cent and the density 44 per cent. While this increased ratio of density is in part due to the denser settlement of rural districts, it is mostly due to an increase in the city and village populations. We find that in 1800 there were but six cities of over 8.000 inhabitants, and in 1840 but 44; the number had increased to 226 in 1870. He says: "Speaking roundly, it may be said that in 1790 one-thirtieth of the population was found in cities; in 1800 one twenty-fifth; in 1810 and also in 1820 one-twentieth; in 1830 one-sixteenth; in 1840 one-twelfth; in 1850 one-eighth; in 1860 one-sixth; in 1870 more than one-fifth."

That popular subject of so many writers, "the center of population," is also fully discussed. In 1790 it was "about 23 miles east of Baltimore." It has traveled westward, keeping curiously near the 39th degree of latitude, never getting more than 20 miles north nor two miles south of it. In the 80 years it has traveled only 400 miles and is still found nearly 50 miles eastward of Cincinnati.

The intimate and varied relations between the density and spread of population as shown by the maps of the second part, and the physical features of the country as shown by the maps of the first part, are intensely interesting and varied, but the subject is too fertile to be entered on here.

Part 3d consists of two memoirs and eighteen plates, six of which are maps. They may be said to cover three classes of subjects, one relating to age, sex and birth, the next to mortality, the third to the "afflicted classes." The relative distribution

of the population by age and sex in each of the States is shown by the geometrical method; the geographical distribution of the predominating sex, and of the birth-rate is shown by maps. The relations of the birth-rate map to various others of the atlas are as interesting to the student in physical geography and anthropology as to the political economist. Considered as a whole, the newer and agricultural regions very naturally have a higher birth-rate than the older and denser population. There are several curious areas where a low birth-rate accompanies a high relative number of women, as, for example, a belt in southern New York and another in Ohio. Possibly this fact may be true in the country as a whole, but it is by no means universal. While the chief controlling conditions of the birth-rate are unquestionably social, some interesting and curious relations to physical causes are seen. There is a belt of rather high birth-rate accompanying the Appallachian system from New Jersey to Alabama, cut through by a belt of lower intensity where the Susquehanna River cuts through. It has also other peculiarities, and a comparison of this map with those relating to density of population, the geographical distribution of sex, distribution of wealth, elevation, extremes of climate, and mortality by certain diseases, show that, along this belt at least, physical causes are a most important or controlling condition.

The next series relates to mortality. Four maps show the geographical distribution of relative mortality by certain classes of diseases. Two charts (by geometrical methods) show the distribution of deaths by age, sex, race, nationality, and month of death for each State and Territory, and also the same for certain special diseases. These are accompanied by two memoirs. The work closes with eight charts, showing (by geometrical methods) the distribution by age, sex, nationality, &c., of each of the "afflicted classes" (the blind, mute, insane and idiotic) for each State and Territory. These (prepared by Mr. F. H. Wines) contain methods of illustration which have some very desirable features.

Any commendatory notice of this work which did not speak of its mechanical execution would be most unjust. When we consider the intrinsic difficulties of the case, and moreover that it is the first work of the kind yet made in the United States, we must accord high praise to Mr. Julius Bien, who has done the lithographic work.

It is to be hoped that Congress will allow this atlas to be printed and sold at as low a price as the cost of manufacture will admit.

W. H. B.

ART. XVI.—*On the Chondrodite from the Tilly-Foster Iron Mine, Brewster, New York;* by EDWARD S. DANA. With plates V, VI and VII.*

THE method of occurrence of the Chondrodite at the Tilly-Foster iron mine, near Brewster, Dutchess Co., New York, has been fully described by Professor Dana in a memoir on the Serpentine and other pseudomorphs of the region.† It may be of interest, however, to review the subject again in this place.

The chondrodite forms the gangue of the magnetite, being everywhere disseminated through it in varying proportions. In the parts of the mine where the ore is purest and perfectly firm and solid,--the so-called "blue ore"—the associated chondrodite is sparsely sprinkled through it in small yellow grains, showing no trace of crystalline form.

In the larger portion of the mine as now opened, however, the soft "yellow ore" predominates: the chrondrodite is present in it in much larger quantities, and, like the other associated minerals, it has almost universally suffered extensive alteration A large number of these products of alteration have been described by Prof. Dana in the memoir alluded to. The chondrodite in this "yellow ore" is generally massive; but occasionally fragments of large coarse crystals have been found, some of which measured five or six inches in length. These are always more or less altered; moreover the material of which they are formed is far from homogeneous, masses of magnetite, and also chlorite, being often enclosed. Dolomite is the most constantly associated mineral and occurs in rhombohedrons of considerable size: these, as well as the crystals of chondrodite, are often coated with magnetite.

Better crystals of chondrodite than those just mentioned are sometimes found in what were once cavities in this massive material. Unfortunately these have all suffered from the general alteration and now have little or no luster, and often are not even smooth. These crystals vary in size, being sometimes an inch or two in length. A crystallographic examination of them is seldom possible, but a few of the crystals found allow of it, and the results are described beyond. The form is usually very simple, and the color varies from a deep red to a light yellow.

Material much better adapted for crystallographic study also occurs, though this is rarely true. Narrow veins are sometimes met with, two or three inches across, which were origin-

* Abstract of a memoir, published in full in the Transactions of the Connecticut Academy of Sciences, vol. iii, pp. 67 to 96, prepared for this place by the author.
† This Journal, III, viii, 371, 447, 1874.

ally lined with more or less perfectly crystallized chondrodite, and also with dodecahedrons of magnetite, crystals of ripidolite, and rarely apatite, and then subsequently filled in with dolomite Where this has been the case and the dolomite has remained intact the chondrodite has been protected and the crystals have retained perfectly their brilliant luster and garnet-red color.

The species chondrodite is of especial interest because of its relation to the Vesuvian humite. As shown by Scacchi, and confirmed by vom Rath, the humite crystals are of *three types*, alike in the ratio of their vertical axes but differing in the length of the vertical axes. Chondrodite is identical with humite in chemical composition, and, as shown by the investigation of the Brewster mineral, alike in crystalline form. Until now the correspondence of the two minerals had been proved only for the *second* type. But the Tilly-Foster mine has afforded crystals of each of the three types, and I am therefore enabled to announce a close relation between the two for all the types.

1. *Description of Crystals belonging to Type II.*

Some difficulty was found in obtaining the value of the fundamental angles from the fact that many crystals, though faultless in luster, yet gave uncertain measurements. This was due to the fractured condition of many of the planes, which, though often not very apparent even under a magnifier, yet gave rise to a variety of reflected images in the goniometer, no one of which could be accepted as trustworthy. The presence of these cracks gave the crystals the appearance of having suffered sudden contraction, by which the planes had been irregularly drawn inward, forming re-entrant angles; in fact, in this respect, as in general appearance, this chondrodite might be aptly compared to a resin.

The smallest crystals proved to be free from this cause of irregularity, and one of them, on which the faces were exceptionably brilliant, was chosen for careful measurement. It may be added that all the measurements were made with an Oertling goniometer, provided with two telescopes; but using in the second telescope, in place of the ordinary spider lines, a cross cut in tin-foil illuminated brilliantly by a gas burner —a device for which I am indebted to Prof. Schrauf of Vienna.

The mean of 30 measurements of A (O=001) on r^1 gave: 135° 18′ 50″. The maximum variation from the mean given was ±45″. The mean of 30 measurements of A on e^a gave: 149° 55′ 48″. Maximum variations ± 45″. These were accepted as

the fundamental angles. Calculated from these angles the parameters are:

$$a \text{ (vert.)} = 1{\cdot}57236;\ b = 1;\ c = 1{\cdot}08630;$$

and the angle for the fundamental prism is

$$I \wedge I (110 \wedge 1\bar{1}0) = 58° \ 15' \ 46'' \text{ or } 94° \ 44' \ 14''.$$

TABLE I.

			Chondrodite.			*Humite.*
			$C = i\text{-}\breve{\imath}$ (010) Calculated.	A ∧ O (001) Measured.	Calculated.	A (v. Rath) Calculated.
i	$1\text{-}\breve{\imath}$	011	147° 32′ 39″	122° 44′ (ap.)	122° 27′ 21″	122° 27′ 49″
e^3	$\frac{2}{5}\text{-}\bar{\imath}$	205	90	*149 55 48	149 58 48	
e^2	$\frac{2}{3}\text{-}\bar{\imath}$	203	90	135 59	136 1 17	135 52 15
e^1	$2\text{-}\bar{\imath}$	201	90	109 4	109 3 24	108 57 50
r^1	$\frac{4}{7}\text{-}\breve{2}$	$\bar{2}47$	129 42 9	*135 18 50	135 18 50	135 17 40
r^2	$\frac{4}{5}\text{-}\breve{2}$	245	137 25 45	125 52	125 50 6	125 49 0
r^3	$\frac{4}{3}\text{-}\breve{2}$	$\bar{2}43$	146 27 42	113 25½	113 25 36	113 24 45
r^4	$4\text{-}\breve{2}$	$\bar{2}41$	164 2 9	98 14	98 13 6	98 12 47
m^1	$6\text{-}\frac{\breve{3}}{2}$	$\bar{6}41$	126 43 56	95 22	95 19 40	95 17 59
n^1	$\frac{2}{3}$	$\bar{2}23$	127 1 31		125 3 49	125 2 47
n^1	2	221	135 46 24	103 11	103 10 4	103 9 35

The preceding table* (I) includes the principal angles measured on the same crystal, and also those calculated from the above parameters; in addition, the corresponding angles for humite, type II, are also given, as calculated by vom Rath. The angles of the macrodomes agree very closely, it will be observed, in chondrodite and humite; in the brachydomes, on the other hand, there is a divergence of 6 or 7 minutes.

* Both the symbols of Naumann (in the form used in Dana's "Mineralogy") and also of Miller are given; the signs belonging to each plane are omitted here, as the relations of the planes are shown with sufficient clearness on the spherical projection, Plate VII.

The fundamental form employed is the same as that adopted in Dana's Mineralogy; for the reasons for retaining it, as also its relation to those of other authors, reference must be made to the complete memoir. The letters used are those of Scacchi, with this change, that for the planes of the *third* type the corresponding Greek letters, and for the *first* type the corresponding capital letters, are employed.

			Table II. $A = O(001)$.				Table III. $C = i\text{-}\bar{\imath}(010)$.			
			Calculated.	II.	III.	IV.	Calculated.	II.	III.	IV.
i^1	1-ī	011	57° 33′	57° 28′			32° 27′	{32° 28′ / 32 32		
e^3	$\frac{2}{5}$-ī	205	30 4				90			
e^1	$\frac{2}{3}$-ī	203	43 58½				90			
e^2	2-ī	201	70 57				90			
r^1	$\frac{4}{7}$-2	247	44 41	{44 40½ / 44 40	44° 37′	44° 41′	50 18	{50 7 / 50 30	{50° 13′ / 50 30	50° 12′
r^2	$\frac{4}{5}$-2	245	54 10		54 12		42 34	42 39	42 32	42 36
r^3	$\frac{4}{3}$-2	$\bar{2}$43	66 34	{66 39 / 66 32	66 26	66 35	33 32	{33 31 / 33 32	33 30	33 27
r^4	4-$\bar{2}$	241	81 47	81 52			25 58		{26 0 / 25 57½	
n^1	$\frac{2}{3}$	$\bar{2}$23	54 56				44 14½		44 11	

[redacted]

the following which fall in the old vertical or horizontal zones, and many others to be described later; $o\,(i\text{-}\breve{2} = 210)$, $i^2\ (2\,\bar{i} = 021)$, $i^{a}\,(\frac{4}{7}\text{-}\bar{i} = 047)$, $i\beta = (\frac{2}{5}\text{-}\bar{i} = 025)$, $e^{a}\,(\frac{2}{5}\text{-}\breve{i} = 205)$, $r^{a}\,(\frac{8}{9}\text{-}\bar{2} = \bar{4}89)$. Of these the most interesting is the prism $i\text{-}\breve{2}$, as hitherto no vertical prism has been found on either the 2d or 3d types.

Hemihedrism.—The crystals of chondrodite should show an entire correspondence to humite in hemihedral characters. Taking the same position for the crystals as vom Rath, r^2 and r^4 appear uniformly in the positive (or upper) quadrants, r^1 and r^3 always in the negative (or lower) and n^2 is both + and −, but where occurring alone is generally negative; n^1 is generally, and m^2 is always, negative. Of the brachydomes it may be said that they are often holohedral, but this is not always the case. The various figures on the two plates will show the true relation better than words. It is to be said, however, that when the brachydomes are ± they are still distinguished from each other physically. Thus the + series may be largely developed and rough, destitute of any semblance to polish, when the negative series is as lustrous as the pyramidal planes.

Habit.—With regard to the general habit of the crystals, it is interesting to note the wide variation which is shown. Figures 1, 2, 6, 9, 10 are intended to give some idea of the crystals, as drawn symmetrically, and figures 7, 10, 14, 15, 16, 17, 18, 19, of their actual appearance. As will be seen, the figures are drawn with *C* in front: this was necessary in order to give a true idea of their real appearance. Since the prism $i\text{-}\bar{2}$ is so acute ($49\frac{1}{2}°$) toward the eye the projection gives it but little width. It is hence clear that while fig. 3 is an almost exact reproduction of an actual crystal, fig. 5, by the other method of projection, gives a wrong idea of its appearance.

The crystals from which the partial figures, 7, 10, 16, 17, were drawn, along with others quite as diverse, were all in one single group only half an inch in length. The crystals drawn in figures 16 and 19 also occurred closely conjoined in the same group; and other examples of like diversity in associated crystals might be mentioned. One crystal of a very prismatic appearance (when placed in an inverted position) is shown in figure 19.

Presence of minute planes.—The most remarkable feature of the mineral from this locality is the multitude of minute planes which modify many of the solid angles. One single case will be discussed in detail, as the planes admitted of more than usually exact determination: it serves well to illustrate the subject. A horizontal projection of a portion of the crystal is shown in fig. 14. The crystal itself was small, and unfortunately so imbedded in dolomite that it was for the most part rough

and beyond even approximate measurements. The part ava: able showed C faultless, also r^3 good; and less satisfactory r r^2 and r^4. On the solid angle between C, r^3, and r^2, a lar; number of minute planes were observed; they were so e: tremely small (all covering a surface not ·03 of an inch i breadth) that any exact measurements seemed at first hopeles They were sharply defined, however, and brilliant, and whe the attempt was made it was found that they gave perfectl distinct though faint reflections.

TABLE IV.*

			$C = i\text{-}\breve{\imath}(010)$. Meas.	Calc.	$r^3 = \bar{2}43$. Meas.	Calc.	$i^2 = 201$. Meas.	Calc.
i^2	$2\text{-}\breve{\imath}$	021	17° 37′	17° 38½	23° 58′	23° 49′		
$+x^1$	$\frac{12}{7}\text{-}6$	2·12·7	22 9	21 53	31 4	31 12	8° 21′	8° 37′
$+x^2$	$\frac{26}{9}\text{-}13$	2·26·9	12 55	12 58	29 32	29 27	6 36	6 35
$+x^3$	$\frac{26}{7}\text{-}13$	2·26·7	10 34	10 30	30 37	30 42	8 50	8 54
$+x^4$	$\frac{34}{7}\text{-}\frac{17}{2}$	4·34·7	9 42	9 39	33 41	33 41	12 0	11 53
$-x^6$	$\frac{12}{7}\text{-}24$	$\bar{1}$·24·14	20 21	20 28	21 11	21 6	3 25	3 24
$-x^5$	$\frac{13}{12}\text{-}\frac{13}{5}$	$\bar{5}$·13·12	34 32	34 27	7 32	7 15	21 15	21 8
$-x^7$	$\frac{13}{7}\text{-}13$	$\bar{1}$·13·7	18 50	19 17	19 40	19 47	4 5	4 3
$-x^8$	$\frac{24}{13}\text{-}4$	$\bar{6}$·24·13	22 24	22 31	12 15	11 59	12 22	12 22
$-x^9$	$\frac{5}{2}\text{-}\frac{15}{2}$	$\bar{2}$·15·6	16 5	15 47	18 51	19 7	7 39	7 34
$-x^{10}$	$\frac{13}{7}\text{-}\frac{13}{4}$	$\bar{4}$·13·7	24 22	23 59	9 26	9 47	15 25	15 3
$-y^2$	$\frac{25}{9}\text{-}\frac{25}{7}$	$\bar{7}$·25·9	18 54	19 2	14 45	14 38	14 40	14 52
$-y^1$	$3\text{-}\frac{8}{3}$	$\bar{9}$·24·8	21 55	22 4	13 18	13 14	19 32	19 29
$-y^4$	$9\text{-}\frac{9}{2}$	$\bar{2}$91	11 43	12 13	23 31	23 14		
$-y^3$	$24\text{-}\frac{24}{9}$	$\bar{9}$·24·1	18 45	19 5	25 34	25 27		

The measurements were all taken with the greatest care; an after the calculations had been made, they were repeated; an

* Table VI in the Memoir.

rarely was a variation found greater than two minutes. The preceding table contains the supplement angles for each of these minute planes as measured on *C* and r^3, and also on i^2.

The calculated symbols are also given, with the angles which belong to them. It will be noticed that i^2 is itself one of the minute planes, of the same character as those surrounding it; and its presence gives a reality to them which they would not otherwise have, and shows what degree of reliance is to be placed on the angles.

The symbols* calculated for this series of planes are certainly not simple; and yet a moment's consideration will show that this was exactly what was to be expected. Crowded together so closely, they would be abnormal if occurring on crystals of any species, while this becomes still more true for a mineral like chondrodite. The constantly recurring common planes have ratios which in any other species would be considered next to impossible: thus, in type II, $1 : \frac{1}{3} : \frac{1}{5} : \frac{1}{7}$; and in type III, $1, \frac{1}{3}, \frac{1}{5}, \frac{1}{7}, \frac{1}{9}, \frac{1}{11}$. It is not surprising, then, that these minute planes should themselves have symbols totally at variance with the accepted law of simplicity of the indices.

It will be noticed, however, that, lawless as they appear at first, there is an attempt at system in the symbols given. Thus, in the ratio of the brachydiagonal to the vertical axis, we have:

x^1	12 : 7	y^2	24 : 13	x^7	12 : 7	x^3	26 : 7
x^6	12 : 7	y^1	24 : 8	x^{10}	13 : 7	x^2	26 : 9
		y^3	24 : 1	x^5	13 : 12		

and so on.

Almost all of the twenty and more smaller crystals examined showed some of these secondary planes. I have measured, in fact, upward of one hundred of them. Examples of a number of them are shown in the figures on the plates and their angles are given in several tables in the original memoir. The description of the one case above given is sufficient for this place.

Twins.—The humite crystals of Vesuvius, as well as the Swedish chondrodite, has been shown by vom Rath to possess so great a tendency to twinning that it is a little remarkable that the contrary should be true of the mineral from Brewster. Figs. 20, 21, show the only method of twinning which has been found. The axis of revolution here is the vertical axis of the crystal, and the composition-face the basal plane *A*. Unfortunately the crystal in question was quite imperfect, and all that was available is shown in the figure. A revolution of the

* In the symbols given in the tables (i. e., those according to Naumann) the mark over the second figure, or fraction, has been omitted (in order to simplify the work of the printer). This has also been done in all the following tables, being made possible by the fact that all these planes, with one or two exceptions, belong to the *macrodiagonal* series.

kind mentioned (in a perfectly symmetrical crystal) would, so far as this half of the crystal goes, have the effect only of making it holohedral, giving no re-entrant angles; but, in case of any irregularity, it might give, as here, a re-entrant angle in the planes which are hemihedral in their occurrence.

The measurement of the supplement re-entrant angles here observed gave for $m^3 \wedge \bar{m}^3$, 10° 38′ and 10° 40′; required 10° 39′.

A noteworthy fact in the crystal is the occurrence of the prism o (i-2 =210), the first time that any of the vertical prisms has been observed in the 2d type of either humite or chondrodite. It lies in both the zones $e^3(201)$, $n^3(2\bar{2}1)$, and $e^3(22\bar{1})$, $n^3(2\bar{2}1)$ which answers sufficiently to determine what it is; and the result thus obtained is fully sustained by good measurements. This plane is distinctly present on one side only of B: on the other side its presence is barely indicated. Its place here is taken by a well polished and conspicuous plane Φ, which is another striking instance of the peculiar nature of this species. The index was calculated for each pair of measurements 38° 14′, 39° 24′ on e^3(201 and 20$\bar{1}$) and 4° 31, 6° 31 on m^3(641 and 64$\bar{1}$), and the results obtained were identical. From the first pair of measured angles $\Phi \wedge B$ was found to be 34° 30½′, and from the second $\Phi \wedge B$=34° 31′ (required 34° 32′ 38″). The index obtained was $60\text{-}\frac{38}{10}$ or 60·38·1, and, abnormal as it certainly is, it expresses the exact position of the plane.

An interesting crystal is shown in fig. 4. It is conspicuously hemimorphic, as far as the form goes. It is large, and admits only of approximate measurements; but there is no doubt that the planes as given have been determined correctly. It is altogether probable that a revolution parallel to the basal plane would form an ample explanation of what is observed.

Chemical composition.—I am glad to be able to add here the results of a chemical examination of the chondrodite of the 2d type from this locality, by Mr. G. W. Hawes of the Sheffield Scientific School.

The material analyzed by Mr. Hawes consisted of fragments of crystals of the 2d type, selected with great care to avoid the presence of any altered material. It had a deep garnet-red color and a brilliant vitreous luster. Its specific gravity, as determined by Mr. Hawes, was 3·22. Two analyses gave:

	Analysis I.	Analysis II.
Silica	34·10	34·05
Magnesia	53·17	53·72
Ferrous oxide	7·17	7·28
Alumina	·48	·41
Fluorine	4·14	3·88
	99·06	99·34

Following the view of Rammelsberg (that, in consequence of the unavoidable loss in the course of the analysis, the higher value of each constituent comes nearest to the truth,) Mr. Hawes's analysis becomes as follows. For comparison the results obtained by vom Rath for 2d type crystals from Vesuvius and from Sweden are added.

	Chondrodite.		Humite.
	Brewster, N. Y., *Hawes.*	Sweden, *v. Rath.*	Vesuvius, *v. Rath.*
Silica	34·10	33·96	34·02
Magnesia	53·72	53·51	59·23
Ferrous oxide	7·28	6·83	1·78
Alumina	0·48	0·72	0·99
Fluorine	4·14	4·24	2·74
	99·72	99·26	98·76
Silicon	15·91	15·85	15·88
Magnesium	32·23	32·11	35·54
Iron	5·66	5·31	1·38
Aluminum	0·26	0·38	0·53
Fluorine	4·14	4·24	2·74
Oxygen	39·78	39·58	41·54
	97·98	97·47	97·61

Transforming the iron into an equivalent of magnesium, as also the alumina ($2Al=3Mg$), Mr. Hawes obtains further:

Silicon 15·91, Magnesium 35·00, Fluorine 4·14, Oxygen 39·78.

From these values a formula is deduced, which is essentially that of the Swedish mineral according to v. Rath,

$$20(Mg_5Si_2O_9)+Mg_5Si_2Fl_{18}.$$

It would have been extremely interesting to have added analyses also of crystals of the 1st and 3d types; but, as will be apparent from what follows, the material was not to be obtained.

In completing the description of this variety of the mineral, it may be repeated that it occurs usually in narrow veins, and when free from alteration has uniformly a deep *garnet-red* color. A *cleavage* such as exists in humite (parallel to the basal plane), and has been observed by Kokscharow on chondrodite from Pargas, could in no case be discovered. The fracture is always conchoidal.

2. *Description of Crystals of Type III.*

The crystals of the 3d type are exceedingly rare, three or four specimens being all that have thus far been found, and from these only two individual crystals could be obtained which

allowed of measurement. Fortunately these two crystals are very satisfactory, being small and brilliant, and establish the fact as well as hundreds could do. Figures 11 and 12 show one of the crystals, and figure 13 the other. The appearance of the first crystal is best shown in the second of these figures. As will be seen, the planes are the same as in humite, and they are for the most part hemihedral and situated in the same way. No brachydomes are visible, the edge being rounded and rough.

TABLE V.*

			Chondrodite. $A = O$ (001). Calc.			Meas.(XX).		Meas.(XXI)		Humite. v. Rath. Calculated.		
e^4	4-ĭ	041	100°	1′	7″							
e^3	2-ĭ	021	109	27	35					109°	27′	54″
e^2	1-ĭ	011	125	14	49					125	15	18
e^1	$\frac{2}{3}$-ĭ	023	136	40	4					136	40	34
ρ^3	$\frac{8}{11}$-2̄	2̄811	131	26	51	131°	46′	131°	24′	131	24	49
ρ^4	$\frac{8}{9}$-2̄	289	125	50	6	125 125	37 47	125	48	125	49	0
ρ^5	$\frac{8}{7}$-2̄	2̄87	119	19	18	119 119	35 15	118	36	119	18	19
ρ^6	$\frac{8}{5}$-2	285	111	51	38	111 111	44 49	112	0	111	50	50
ρ^7	$\frac{8}{3}$-2̄	2̄83	103	32	4	103	41	103	38	103	31	33
ρ^8	8-2	281	94	35	16	94 94	31 13	94	48	94	35	4
ν^1	$\frac{4}{7}$	447	132	17	48			132	16	132	16	43
ν^2	$\frac{4}{5}$	445	123	1	8			122	32	123	0	8
ν^3	$\frac{4}{3}$	443	111	18	7			111	5	111	17	23
ν^4	4	441	97	24	20			97	29	97	24	3

The second crystal is of very different form, and was imbedded in brucite, and entirely free in it. It was perfectly formed on all sides, being almost as perfect as the drawing, with the exception, however, of the acute (brachydiagonal) edge, which was mostly broken. When only the upper part of the crystal is

* Table XII of the memoir. Other angles of these crystals are given in Table XIII.

considered, it will be seen that the hemihedrism is like that in the other case, except that ρ^{8} is holohedral. For macrodomes there are $i^{1}(\frac{2}{3}\text{-}\bar{i}=023)$, $i^{2}(1\text{-}\bar{i}=011)$, $i^{3}(2\text{-}\bar{i}=021)$, $i^{4}(4\text{-}\bar{i}=041)$; the last has not been observed on humite. On measuring the planes below, it was found that they were not distributed as was expected in accordance with the monoclinic character of the crystal; instead, either extremity of the brachydiagonal axis was differently developed. There are present also at one extremity $\pm e'(\frac{4}{7}\text{-}\bar{i}=407)$, though the plane could be only approximately measured. This is probably also to be explained as having resulted from a revolution parallel to the basal plane. The crystal was very small and not at all adapted to experiments having in view the discovery of any proper hemimorphic development. Some of the angles measured on both these crystals are contained in the preceding table.

Unfortunately the inclination to C on no one of the pyramidal planes could be measured with perfect accuracy; the measurements are good, yet not entirely trustworthy. These planes, though brilliant, are uniformly fractured in the manner already explained, and this made all the angles a little uncertain. The calculated angles as given have as their basis the prismatic angle $I \wedge I = 94° 44' 14''$, and the macrodome angle $C \wedge i^{2} = 144° 45' 11''$, following the analogy of humite in which the vertical axes of types II and III have the ratio 10 to 9.

The corresponding parameters are:

$$a\,(\text{vert.}) = 1{\cdot}41512;\ b = 1;\ c = 1{\cdot}08630.$$

Very little further can be said in regard to the crystals of the 3d type. Those observed had a somewhat different color from those of type II; that is, the color was more yellowish, less of a pure garnet-red—though this may be accidental. No analysis was possible of course. The method of occurrence was much like that of the brilliant crystals of the second type; and the associated minerals were the same, with, probably as a later formation, brucite.

3. *Description of Crystals of Type I.*

The occurrence of large coarse crystals of quite impure chondrodite, imbedded in the massive material, has already been described. These belong, at least in part, to the *first* of Scacchi's types. As has been remarked, the crystals of this character do not often admit of exact determination, but in two cases they were so good as to allow of their crystallographic relations being accurately made out. The accompanying wood-cuts, figures 22 and 23, give faithful representations of their appearance and size. It will be seen that they are both quite imperfect, and

it was on this account that no attempt was made to make a symmetrical drawing of either of them.

Fig. 22.

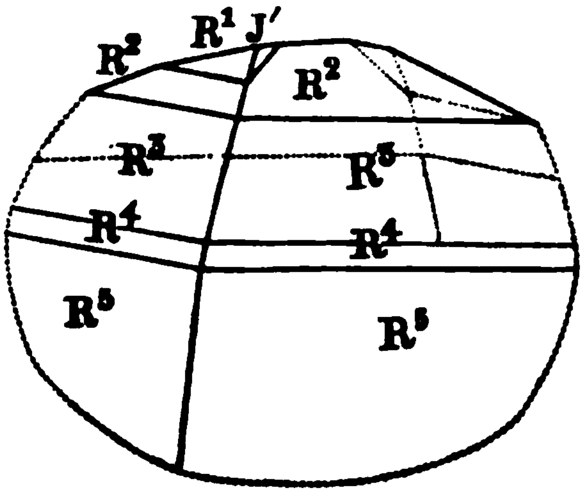
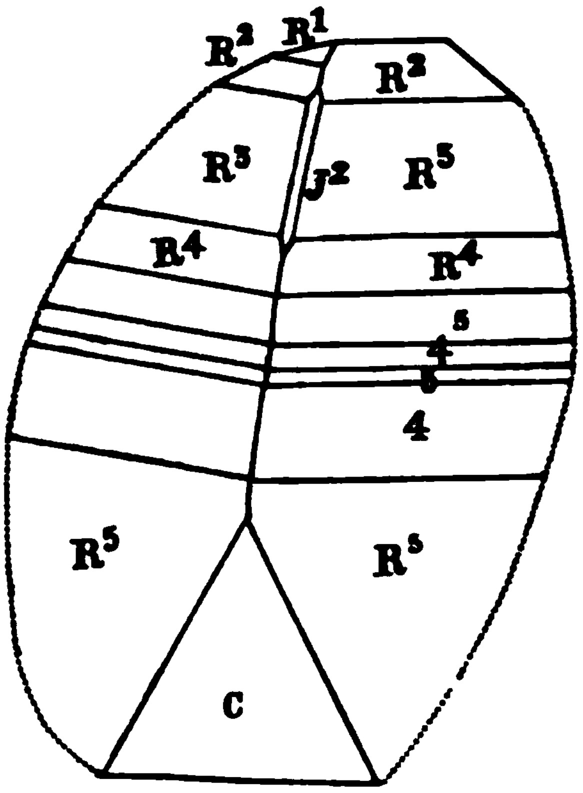


Fig. 23.



R^3 on R^3 (behind) gave measurements varying, in a series of trials, from 78° to 79°: required 79° 4′.

R^3 on R^3 (behind) gave 62½°, required 63° 1′.
R^3 on R^3 (behind) gave 72, required 71 17½.
R^3 on R^3 (behind) gave 72, required 71 17½.

These angles on both crystals were identical within the allowed error of observation (say 30′). The above are the best angles afforded by any of the planes.

These angles can be referred only to the 1st type of humite. Decisive proof that this is right is found in the fact that both crystals are *holohedral*, the planes on both sides being identical, with the exception of R^1.

The measured angles of C on R^5, right and left, were identical, though not obtainable with exactness; the measurements gave 152½°–154°: this is also true for C on R^3, right and left, =140½°–142½°.

The following table includes the most important angles for the occurring planes, calculated from the fundamental form of the second type on the assumption that the lateral axes are equal and the vertical axes have the ratio of 14 : 15. The measured angles are also added, though only approximate; in the form given they were obtained immediately from the measurements over the top of the crystals (see above).

The two crystals described are the only ones which could be positively identified. It is very probable, however, that of those found others also belong here, as they have much the same appearance and habit. These crystals are all considera-

bly altered, being generally soft enough to be cut with a knife, and for this reason a chemical analysis would be of little value.

TABLE VII.*

			Chondrodite.							Humite.		
			$C = i\text{-}\breve{i}$ (010). Calculated.			$A = O$ (001). Meas.	Calc.			v. Rath. Calculated.		
J^2	$1\text{-}\breve{i}$	011	145°	43′	44″		124°	16′	16″	124°	16′	46″
J^1	$\frac{3}{5}\text{-}\breve{i}$	035								188	38	38
R^1	$\frac{3}{5}\text{-}\bar{2}$	3·6·10	129	12	57	136°	135	53	35	135	52	23
[illegible]	$\frac{3}{4}\text{-}\bar{2}$	368	134	28	38	129½	129	32	3	129	30	52
R^3	$1\text{-}\bar{2}$	122	140	30	10	121½	121	45	28	121	44	23
R^4	$\frac{3}{2}\text{-}\bar{2}$	364	147	6	34		112	25	28	112	24	37
R^5	$3\text{-}\bar{2}$	362	152	49	49	101	101	39	30	101	39	2

The color of the crystals is gray to grayish-yellow, and the material of which they are composed is never pure, and often quite heterogeneous.

4. *On the Optical Properties of Chondrodite.*

In the preceding pages the question of the orthorhombic or clinorhombic crystallization of the chondrodite has not been discussed. In fact, nothing was detected by the measurements sustaining any other conclusion than that of Scacchi and vom Rath, that the crystals were fundamentally orthometric. Still the hemihedral character of the second and third types seem to point to a clinometric form, and this is apparently supported by the optical characters obtained. The material available for optical investigations was very scanty, and, with the exception of one crystal, poorly adapted for the purpose.

The crystal referred to was, properly, but the fragment of what was originally a specimen of considerable size and beauty; when unbroken it must have been nearly an inch in length. In the condition in which it was found it showed only the brachydomes e^1 and e^2, with the pyramids n^1, n^2, and m^2; it had the deep garnet-red color of crystals of the second type, and with the exception of the universally present fractures was perfectly clear and transparent.

* Table XIV of the Memoir.

Guided by the observations on the optical properties of humite made by Descloizaux and given in his Mineralogy (p. 14), a section was cut from the crystal described parallel to *C*, i. e., perpendicular to the brachydomes present. The examination of this section showed: 1st, that the acute bisectrix is normal to C (i-$\breve{i}$, 010); 2d, that this bisectrix is positive; 3d, that the optic-axial angle is large, the axes being seen only when oil is used; but 4th, that *the axes do not lie in the basal plane*, but in a plane making an angle of about 154° with it. This last point was so unexpected and anomalous that every effort was made to explain the measurements in some other way, but with no success. By means of a stauroscope, made by Fuess in Berlin after the excellent pattern of Groth, the position of the two axes of polarization, as referred to e^1, and also to e^2 in plane *C*, were carefully determined. The measurements were repeated twenty times, the error arising from an imperfect adjustment of the Nicols being eliminated in the usual manner. The result was as follows:

Supplement angle made by the plane of the axes—

with e^1 ($\frac{2}{3}$-$\breve{i}$=203), 18° 9′; hence with the basal plane, *C*, 25° 50′.
with e^2 (2-$\breve{i}$=201), 45° 9′; " " " *C*, 25° 46′.

In order to confirm these results, other crystals were sought, which would admit of like determinations. None could be found which would serve for measuring the axial angle; but two small ones, on which the plane *C* was naturally developed, proved to be clear enough to allow of measurements with the stauroscope. The first alone gave accurate results; on it the angle of the same plane with e^a($\frac{2}{5}$-$\breve{i}$=205) was determined with equal care. The results were:

4° 55′ for the angle with e^a; and hence 25° 59′ with *C*.

The agreement with the angles given above is as close as could be desired. In the other case, the rather rare plane B(i-$\bar{i}$=100) was present; the crystal was minute, however, and the determination only approximate. It was found that the normal to the axial plane made with *B* an angle of 65°–70°, and hence with the normal to the basal plane 20°–25°.

With so ample confirmation the point made cannot be even questioned, and it remains to reconcile it with the crystallographic properties of the species. It will be seen at once that the position of the optic axes is totally at variance with the accepted orthorhombic character of the crystals; but it conforms to the rule of monoclinic crystals, as one axis of polarization is normal to the plane of symmetry *C*, and the others lie in it, or in other words, the optic-axes lie in a plane perpendicular to the axis of symmetry. The angles measured and calculated,

given in the various tables, show that the variation from the rectangular type, if it really exist, must be very slight, as the agreement between the angles measured and those calculated on the assumed prismatic basis is very close—it being remarked that some considerable variation in the angles given in the tables are simply explained by the imperfection of the crystals. Note the angles measured for $m^2 \wedge \bar{m}^2$ on the twin crystals described on page 96. It was not to be expected that the variation in the optical character of the crystals would be so decided in view of the slight divergence which is possible in the crystalline form. I reserve for the future the careful revision of the angles of this species, when I shall hope to be able to command a more abundant supply of satisfactory material. It may be added that the hemihedral character of the second and third types of humite long ago suggested the idea that they were oblique in form; but all the crystallographic investigations thus far have seemed to deny this. In the Mineralogy of Brook and Miller, the form is made oblique, but this seems to be due to a misunderstanding of the planes occurring on the crystals.

The axes, as already mentioned, do not appear distinctly except in oil; in the first mentioned section they admitted of good measurements. The mean of thirty determinations of the angle for red rays gave—

$2\ H\alpha = 88^\circ\ 48'$: the extremes being $88^\circ\ 36'$ and $89^\circ\ 0'$.

With a yellow light (sodium) the angle was essentially the same, but the mean was 10′ or 15′ smaller, which would indicate that the dispersion is $\rho > v$, but the matter cannot be considered to be beyond doubt.

The index of refraction of the oil employed, as determined by Professor Wright and myself, was 1·466.

In conclusion, I have to express my very great obligations to Prof. Allen for his kindness in giving me free use of all the specimens in his valuable cabinet. Both of the crystals of the third type, as well as several others mentioned, came from his collection; in fact it was Prof. Allen who first made known the special interest connected with the locality. To Mr. Cosgriff, the superintendent of the Tilly-Foster Iron Mine, I am also much indebted for his uniform kindness and courtesy to me at the several occasions when I have visited the mine, and also for the gift of several fine specimens.

Art. XVIa.—*On an easy method of producing Di- and Trinit[ro]phenetol;* by Peter Townsend Austen.

The usual way of producing these nitrophenetols is eith[er] by digestion of ethyl iodide with sodium di- or trinitr[o]phenylate in a closed tube,* or by direct nitrizing of t[he] phenetol.† The following procedure will be found more sati[s]factory.

Di- or trinitrochlorbenzol is dissolved in absolute alcoh[ol] and about twice the calculated amount of sodium necessary f[or] the reaction,

$$C_6H_3(NO_2)_2Cl + C_2H_5ONa = C_6H_3(NO_2)_2OC_2H_5 + NaCl$$

gradually added in small pieces. The liquid becomes deep re[d] and under violent evolution of hydrogen finally boils from t[he] heat of the reaction, while a brown crystalline precipitate se[p]arates. After solution of the sodium, water is added and t[he] liquid then acidified with hydrochloric acid. After filtering a[nd] washing with water, the nitrophenetol may be obtained pe[r]fectly pure by treatment with animal charcoal and recrystal[li]sation from boiling absolute alcohol. The purity of the d[i-] and trinitrophenetol thus obtained was established by fusi[ng] point and analysis.

It is very striking in this case that the nitro-groups are n[ot] reduced by the violent evolution of hydrogen, or that they a[re] not azoxized by the hot alcoholic alkaline solution.

Mononitrochlor-benzol treated in this manner yielded on[ly] the known dichlorazoxybenzol.‡ From higher alcohols wi[th] which the hydrogen evolution was not so violent, dinitrobro[m]benzol gave no satisfactory results, black slimy bodies, appa[r]ently products of a partial reduction being all that I obtaine[d]. With benzylalcohol I obtained also no dinitrophenolbenzylest[er] but a yellow substance separating from a boiling alcoholic sol[u]tion as an oil, and slowly solidifying to an imperfectly crystalli[ne] mass. I have not yet been able to obtain a sufficient amou[nt] for a thorough examination, but from a preliminary analysis [it] appears to be a dinitrodibromazoxybenzol.

Royal Laboratory of Berlin, May 10th, 1875.

* Körner, unpublished research; Kekule's Org. Chem., iii, 77.
† Cahours, Ann. Chem. Pharm., lxxiv, 299; lxix, 236.
‡ Hermann, Deutschen chem. Ges., 1872, 910.

ART. XVII.—*On a fœtal Manatee and Cetacean, with remarks upon the affinities and ancestry of the Sirenia;** by Prof. BURT G. WILDER, of Cornell University.

A fœtal Manatee.—The fœtal Manatee here described was obtained by Professor James Orton† at Pebos,‡ Peru, upon the Marañon, a tributary of the Amazonas.

Detailed measurements are reserved for a more extended article, but the following will be found useful.

	Grams.
Present weight,	11·
Original weight (estimated by comparison with a fœtal pig of nearly the same size, preserved in spirit),	22·
	Meter.
Present apparent length. vertex to root of tail, (2·3 inches)	·055
Original apparent length (estimated as above), (2·6 inches)	·059
Tip of muzzle to ear	·020
Ear to point opposite anus	·037
Point opposite anus to tip of tail	·028
Real length, as if extended, (3·7 inches)	·085
Tip of muzzle to depression between eyes	·011
Between eyes to vertex	·015
Total length of head	·026
Greatest width of tail	·011

It is not very easy to state the dimensions of this fœtal manatee so as to permit accurate comparison with other fœtal or adult individuals. This is owing less to the distortion of the trunk by lateral pressure in packing for transportation, than to the non-conformity of the axes of head, trunk and tail, which, in the adult, nearly coincide.‖

With adult animals a common measurement is from "tip-to-tip;" from the muzzle to the end of the tail. It is evidently inappropriate to measure directly between these points in this or any other young fœtus; and almost equally so to follow the

* Abstract of portions of a communication to the Boston Society of Natural History, April 7th, 1875.

† Knowing me to be engaged in the dissection of a fœtal dugong (2½ feet long, obtained through Prof. H. A. Ward of Rochester), Prof. Orton very generously transferred the little manatee to the Cornell University.

‡ Murray (3, 302) states that this species "ascends the rivers Orinoko and Amazon for great distances." Upon Map LI the coloring indicates a westward limit in Brazil at about 65° west longitude. The locality above named is about 72° west longitude and 3° south latitude.

The first number of references indicates the number of the work in the list at the end of this paper; the last the number of the *page;* the middle one, when it occurs, the *volume.*

‖ More desirable than even the adoption of a simple (metric) system of weights and measures is the acceptance of a uniform method of weighing and measuring animals and their organs. The aphorism that "figures do not lie" is nowhere less true than in zoölogy.

outer curves of the head, trunk and tail. But while we may feel sure that the truth lies between these two extremes, it is not easy to decide upon the points which should be traversed by a straight line representing the total length. The measurements here given may therefore be regarded as only approximately true to nature.

The head is sharply bent upon the chest. The armi (anterior limbs) are likewise pressed flat upon the chest, the left manus overlapping the right. (In the photograph the manus is represented as projecting forward). The tail forms nearly a right angle with the trunk. Upon its ventral border near the tip is a minute median papilla, which does not appear to have been observed in larger specimens; but there is no trace of the notch or depression described by Dr. Murie in both of his specimens (1, 128); neither does there appear the raised border described by the same author (1, 133).

The abdomen is closed but the umbilicus is large, ·004 in diameter. The umbilical cord is not present, but there projects a loop of intestine about ·040 long, together with a delicate membraneous tube which is apparently connected with the intestine and is probably the remains of the yolk sack. (This will be fully described when the dissection is made).

The clitoris is large, ·003,2 in length. By its caudal deflection it covers the genital and anal orifices.

The brain was softened and its parts hardly distinguishable. It will be described hereafter. (The photograph was taken after its removal by a longitudinal incision). The extent of the cavity is approximately indicated by the dotted line.

There is no external ear, and the orifice of the auditory meatus is a minute round hole* with wrinkled borders as in the adult. A pigmentary deposit in the surrounding skin is all that can be seen by the unaided eye. The skull is prominent at this point, as shown in fig. 4.

The upper and lower eyelids are separated by an elliptical opening, the long axis of which is oblique to that of the head. Its length is is ·001,2. The third eyelid, if it exists, does not appear. By blowing between the lids there is revealed a space surrounding the orifice about ·004 inch diameter; how far this represents the size of the globe can only be known by dissection.

The nostrils have the same form as in the adult, but owing to the squareness of the muzzle, they do not appear upon a front view.

*At the time this communication was made the writer thought he had found an anteverted triangular pinna. It proves to exist upon only one side, and has probably been produced artificially. Its position is just behind that of the meatus, and it closely resembles the early stage of the pinna in swine.

fœtal Cetacean.—Fig. 6 represents, of natural size; a fœtal an kindly loaned by Mr. Alex. Agassiz, Curator of the ım of Comparative Zoölogy.

ɜ specimen is labelled *Talcahuano, Chili*, and was given to te Prof. Agassiz upon the Hassler expedition. The donor, d whaler, said it was from the "Hump-back whale," *ptera*). But, aside from its small size, the blow-hole is a : transverse aperture as in Delphinidæ; so that unless we ıe that a transformation could occur so as to divide this wo holes, longitudinally or obliquely placed, we must re- .t as the embryo of a porpoise or dolphin.

	Meter.
h from vertex to root of tail opposite anus, (2·3 inches)	·055
' muzzle to supposed location of auditory meatus	·015
ory meatus to opposite anus	·042
ıite anus to tip of tail	·018
ength as if extended (2·9 inches)	·075

ɜ smallest cetacean fœtus of which I have found record ais, 4,323, pl. XVII) was ·102 (about four inches) long; it igned to the common dolphin, *Delphinus delphis*. The ıl aspect is similar in the two, but Gervais' figure has the and lower jaw of equal length, while in the specimen ıgured the lower projects about ·001 beyond the upper.

ɜ blow-hole is a transverse aperture ·004 long. Its lips are ed and tumid, and the posterior has a distinct hinder r. The eyelids are closed.

ɜ tail is narrow and lancet-shaped, with no trace of a ıal notch No trace of dorsal fin is apparent, but as the ɜ of the back is somewhat abraded by friction during ›ortation, it is not impossible that a rudimentary fin ex- as in Gervais' specimen. The vertical crest, mentioned yman (6), exists above and below the tail.

sting views respecting the affinities of the Sirenia.—At the ıt day no zoölogist follows Rondeletius (7) in enumerating ıanatee and dugong with the fishes, and very few adopt r's arrangement of them as "Herbivorous Cetacea."

, the hiatus between the Ungulata and the adult manatee ugong is so great as to lead to the general recognition of ıtter as a distinct order, Sirenia (Brandt, 2 *fere*; Murray, ; Owen, 12, ii, 281; Huxley, 13, 387); and three recent rs, by a kind of taxonomic reversion, seem to be again ly impressed with the striking outward resemblances of ɨult Sirenia to the Cetacea. The late compiler of the ›gue of Seals and Whales in the British Museum includes anatee and dugong among the Cetacea; Gray, 15, 62. el (14. 545, 556) recognizes their affinities with the ata, but makes the Cetacea the descendants of the Sirenia.

The most recent writer concludes an able anatomical description of the manatee with a diagram, in which equal weight seems given to the cetacean and ungulate relations of the Sirenia (Murie 1, 190).

Dr. Murie continues as follows: "Is it (the manatee) a retrograde, dwarfed or undeveloped Elephant? a 'true embryonic type of Pachyderms,' as the elder Agassiz puts it (9). Is it a partially converted Cetos? Is it the reflex of unknown and antedated swarms of mammals of intermediate organization which would fill up the chasms of structural differentiation, yielding lines of demarcation to modern systematists? Such interrogations, to be answered satisfactorily, require a more comprehensive knowledge of the embryology of Pachyderms and Cetacea, a far greater acquaintance with allied fossil forms, a better appreciation of what constitute transitional links, and a further profound investigation into the principles of the doctrine of evolution."

It will be noted that, although Dr. Murie uses the word *retrograde* in his general query respecting the affinities, the idea is not distinctly enunciated. For while embryo Pachyderms and Cetacea are mentioned as likely to throw light upon the problem, those of Sirenia are not alluded to. This is not so strange in view of the fact that the smallest fœtus then known (Daubenton, 22) was about ten inches long (·254) and already unmistakably a manatee.

Affinities of the Sirenia.—The likeness of the fœtal manatee's head to that of some ungulate quadruped is as obvious as is its unlikeness to the head of the fœtal cetacean. The following considerations seem to warrant our attaching more importance to these resemblances than to those features of the trunk and limbs which, in the adult forms, seem to separate the Sirenia from the Ungulata and to unite them with the Cetacea. "In the eyes of most naturalists, the structure of the embryo is even more important for classification than that of the adult. In two or more groups of animals, however much they differ from each other in structure and habits, if they pass through closely similar embryonic stages, we may feel assured that they are all descended from one parent-form and are therefore closely related." (Darwin, 24, 403).

It is to be borne in mind that resemblances may be of two kinds. 1. Those features which are common to the earlier stages of development with all members of larger groups. 2. Those which are peculiar to smaller groups. The former are relatively *negative;* the latter, relatively *positive.*

In the case of the manatee the large tail, the absence of hinder limbs, the pinniform manus, the flexion of the head upon the chest, and the absence of external ear; these charac-

a certain stage with all mammalian embryos, and have r a general significance as indicating a remote common iilar origin within the mammalian class. Nor does the)lance they may involve with the Cetacea require us to the latter as nearly related to the Sirenia.

all mammalian embryos have, in the earlier stages, a high)unded head with a short facial region. With an "em-ic type" like the Sirenia we should expect to find in the o an especially high and rounded head and a short face. eas the height of the head is by no means excessive, and :ial region is greatly prolonged. Now this is what exists adult pig, horse, and hippopotamus.

ong human beings, likeness to relatives and to ancestors, or less remote, is usually recognized in the form of the the shape or expression of the features. The same value e attached to resemblances among animals only in so far re is community of structure underlying the external re-ance.

s admitted by nearly all that the anatomical resemblances which affinities are recognized are much greater between irenia and certain Ungulata than between either of these s and the Cetacea.

:re would seem to be reason, therefore, for attaching very .erable taxonomic value to the fact that the head and face s fœtal manatee resemble not those of cetaceans, but those tain Ungulata; notably hippopotamus, pig and horse.

bable ancestors of the Sirenia.—In the discussion of this on several matters must be considered.

Few now dissent from the doctrine of Darwin, that "de-is the hidden bond of connection which naturalists have eeking under the term of the natural systems." (24, 403.) all zoologists the Sirenia are regarded as an inferior type, er as an order among Mammals, or a sub-order or family : Ungulata in general, or of the more restricted groups 'derms or Perissodactyla.*

: group is well named by Dana "*Urosthenic aquatic* Her-es;" (21, 160); and it is a source of gratification to all hat eminent naturalist now admits that the terms above with others introduced in his works, may have an actual ce of a purely ideal signification.

is an almost universally accepted rule that the earlier of animals resemble the permanent conditions of *lower* This is stated by Dana as follows: "As a species in)pment passes through successive stages of progress, rela-rade in inferior species may often be determined by com-

se these terms for convenience and not because I regard them as express-ural relations.

paring their structure with these embryonic stages. * * * As the young of the frog (tadpole) has the tail and form of a salamandrian, therefore the salamanders are higher than the frogs." (20, 592.)

In accordance with the above rule, and upon the hypothesis of evolution, we should expect the embryo hippopotamus to resemble a manatee, and the embryo manatee to look "very like a whale." But since the young manatee has a head like an adult hippopotamus, we must either reverse the usual opinion as to the relative rank of the aquatic and terrestrial Ungulates, or qualify the rule above stated so as to meet the present case.

This apparent discrepancy between generally accepted views as to the coincidence between rank and stages of development seems to be accounted for by the doctrine of Retrograde metamorphosis, alluded to by Darwin (24) and Hyatt (26) and perhaps by other authors.

The following passages from the "Origin of Species" are especially applicable.

"The embryo in the course of its development generally rises in organization; I use this expression, though I am aware that it is hardly possible to define clearly what is meant by the organization being higher or lower. But no one probably will dispute that the butterfly is higher than the caterpillar. In some cases, however, the maturer animal must be considered as lower in the scale than the larva, as with certain parasitic crustaceans." (24, 396.)

"Recent forms are generally looked upon as being on the whole higher in the scale of organization than ancient forms; * * * this fact is compatible with some forms having retrograded in organization, by having become at the last stage of descent better fitted for changed and degraded habits of life." (24, 426, also 402 and 397.)

"Slight variations generally appear at a not very early period of life and are inherited at a corresponding not early period." (24, 399 and 316.)

"Whatever influence long-continued use or disuse may have had in modifying the parts of animals will chiefly or solely have affected them when mature * * * and the effect thus produced will be transmitted to the offspring at a corresponding mature age." (24, 401.)

"This process, while it leaves the embryo almost unaltered, continually adds, in the course of successive generations, more and more difference to the adult. Thus the embryo comes to be left as a sort of picture, preserved by nature, of the ancient and less modified condition of the animals." (24, 316 and 403.)

In other words, the idea of evolution, whether of individuals

ıps, *primarily* involves an increase in complexity and an e in rank; but it is perfectly compatible with a sub· t retrograde metamorphosis, more or less extensive ac- ɟ to the rank already attained. Using the terms in their rather than their usually accepted sense, evolution pri- involves *ascent*, but it is perfectly compatible with *de-*

n the derivative hypothesis all evidences of a parallelism comitancy between individual metamorphosis and the on of types toward a more perfect condition are equally in favor of the conclusion that the retrograde metamor· of an individual indicates that the group to which it be- s upon the downward rather than the upward path.

n the hypothesis of evolution we may regard exceptions rule quoted from Dana as to the resemblance between ·lier stages of higher forms and the permanent condition er, as strictly in accordance with the more universal at *the earlier stages of animals resemble their more or less ancestors;* if these are lower in rank, as is usually the ıen the commonly accepted rule will hold good; but er, as is here suggested of the Sirenia, then that rule would hile the more universal one would still be kept.

idea that existing Sirenia are the result of a retrograde ion is supported by the very arguments which Brandt against the ordinary view of progressive development. ·s: "To the supposition that *Halitherium* has given rise other and later genera are opposed many considerations. ıe *Halitheria*, in addition to the well-developed pelvis ed with acetabula, had rudiments of hinder limbs (fe- ı), in which respect they approximated the more perfect s more nearly than do the existing genera; while on the ·y, according to the theory, we should look for a perfec- ' body gradually evolved and a more complex structure, *licore*, *Manotus* and *Rhytina*, rather than in the *Hali-* ' (Brandt, 2370.)

Deinotherium * be regarded as a Sirenian with limbs yet eveloped then in *Halitherium*, then the series is at least onally intelligible.

ːourse the above considerations in no way account for or existence of the hypothetical stem-form of quadrupeds

'wen (12, ii, 282); Huxley (13, 431); Haeckel (14, 560); Brandt (2, 190); 90), the Deinotherium is regarded as a Proboscidian; but it is in- nong the Sirenia by De Blainville and St. Hilaire (Murray, 3, 198), Dana, ay, 3, 190, and L. Agassiz. According to the placental classification of ınd Haeckel, the Proboscidia are in one great group Deciduata, while ıia are in the other, but provisionally, since their placentation is not It would seem that osteological comparisons are not as yet conclusive in

from which the Sirenia may be supposed to have retrograded. Neither do they preclude the idea that they and the other mammals may have been evolved from cetacean forms.

But it must be admitted even by those who may not recognize the ungulate affinities of the Sirenia, that the comparison of these two embryos does not materially lessen the gap between the Cetacea and the other Mammals, upon which Murray has so strongly insisted. 3, 55, 196 and 203.*

As to the zoölogical status of the Sirenia, if the views above advanced are correct, there would seem to be no more ground for their removal from the Ungulata than for the separation of the Pinnipedia as an order apart from the Carnivora. Nor would the comparison be invalidated by the view that the seals may be upon the upward rather than the downward path.

The limits of this preliminary paper will not allow the discussion of the relations of the Sirenia with special ungulate families and genera, or of the relative position of the sirenian genera.†

But there is one point of resemblance between the Sirenia and the Proboscidia upon which, it seems to me, undue stress is liable to be placed, namely: that in both groups the mammary glands are pectoral or axillary, while in the hippopotamus they are inguinal.

The consideration of the variations as to number and position of these organs in other groups shows, however, that in recent times they have never been regarded as of sufficient taxonomic value for the determination of ordinal or even family affinities. (For instances, see Owen, 12, iii, 775–780.)

It may at first seem strange that there are no traces of hinder limbs in this fœtus, and that the front limbs are not more like the legs of its supposed quadrupedal ancestors.

It is by no means *impossible* that an embryo just forming would present rudimentary hinder limbs in accordance with the usual vertebrate type.

As to the manus, it is to be borne in mind that the vast majority of existing vertebrates ‡ have anterior limbs which vary but slightly from the pad-like form which they present in the embryos, and which may be supposed to have prevailed in past times. The quadrupedal pattern is comparatively recent, and has affected so few mammals, especially such as may be

* With the Cetacea it is said that "the apex of the heart is sometimes indented," (Owen, 12, iii, 521). But we need further information upon this point and also respecting the statement of Gratiolet, (16,) that a like condition prevails in the new-born hippopotamus.

† I am inclined to think that a careful study of embryos and brains will be more satisfactory than even such exhaustive osteological comparisons as those of Brandt.

‡ Nearly all fishes, many batrachians, some reptiles, all birds, and a very large number of mammals.

regarded as in the line of sirenian descent, that we may regard its influence as almost inappreciable as compared with the other.

Further discussion of the subject is deferred until the fœtal manatee has been dissected,* and until the writer is able to prepare a longer paper in which the various questions involved may be more fully presented. It is to be hoped that no opportunity will be lost for securing still earlier sirenian embryos and for preserving the membranes.

Summary.

1. The specimens here described are probably the smallest fœtal sirenian and cetacean upon record; measuring, if extended, ·085 (3·7 inches), and 0·75 (2·9 inches), respectively.

2. The head of the manatee is strongly flexed upon the chest, and the tail forms a right angle with the trunk.

3. The general aspect of the head and face of the manatee is ungulate rather than cetacean.

7. To this extent the embryo of a lower form resembles the adult of a higher.

5. This, while contrary to the usually accepted rule, may be really an exemplification of a more comprehensive law; namely, that the *young of animals resemble their ancestors.*

6. This retrograde metamorphosis of the manatee points to a like retrograde evolution of the Sirenia from prior ungulate forms.

7. This idea is confirmed by what is known of the geological succession of sirenian forms.

8. The determination of the affinities of the Sirenia, is likely to be accomplished by the study of brains and embryos rather than by minute osteological comparisons.

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Explanation of Figures.*

Fig. 1.—Partly grown male Manatee, $\frac{1}{18}$ of natural length. Reduced copy of Murie's figure. The eye and ear appear as black spots; *a*, anus; I, M, A. the nails of the index, medius, and annularis digits.

Fig. 2.—Fœtal Manatee, natural size. *n*, nostril; *a*, ancon (elbow); *c*, carpus.

Fig. 3.—Head of fœtal Manatee, enlarged two diameters; the muzzle being raised a little so as to expose the lower lip. The dotted line indicates the extent of the cranial cavity. The external meatus is represented by a black spot.

Fig. 4.—Head of fœtal manatee, seen from above and in front; natural size.

Fig. 5.—Tail of fœtal Manatee, seen from the ventral side; natural size. *cl*, clitoris turned toward the right; *v*, generative opening; *a*, anus; *cp*, caudal papilla.

Fig. 6.—Fœtal cetacean, natural size. *n*, nostril; *uc*, umbilicus; *cl*, clitoris; *a*, anus. The smaller figure represents the lance-shaped tail from the ventral surface.

Fig. 7.—Head of fœtal cetacean, natural size, from above; *n*, nostril.

* The figures, excepting fig. 1, were drawn from nature and from photographs and engraved by Mr. Philip Barnard.

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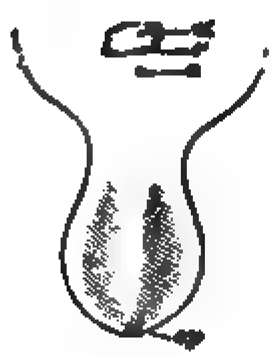

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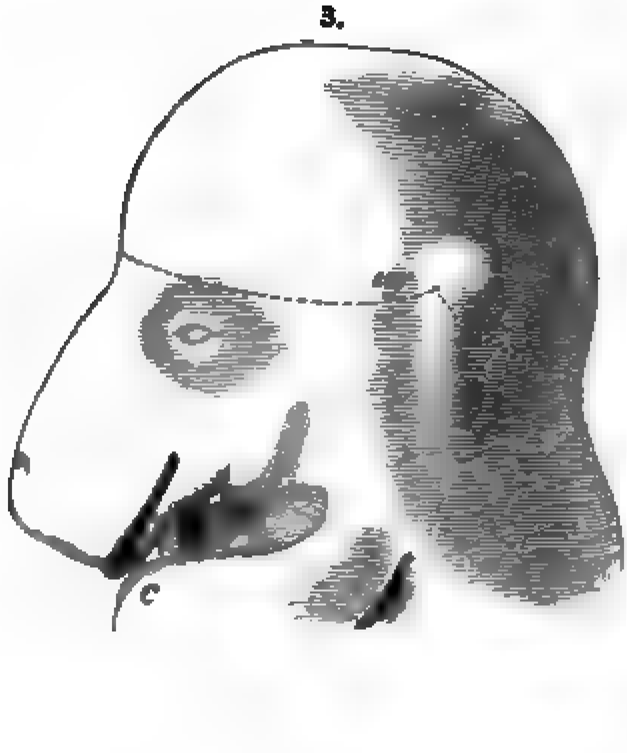

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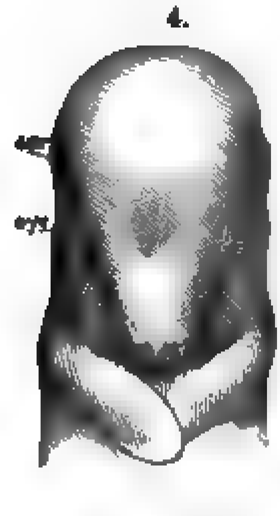


ART. XVIII.—*On Tidal Waves and Currents along portions of the Atlantic Coast of the United States;** by J. E. HILGARD, Assistant in the Coast Survey, Washington, D. C.

1. MOVEMENT OF TIDAL WAVES.

EARTHQUAKE waves originating with an impulse at one definite point, and propagated freely through the ocean in every direction with a velocity depending upon the square root of the depth of the sea, may serve as good illustrations of the manner in which tides are propagated through sounds, bays and rivers. The following table gives the rate of motion for different depths:

Depth in feet.......	10	Miles per hour.......	12·2
" "	60	" "	30·0
" "	100	" "	38·7
" "	1,000	" "	122·3
" "	6,000	" "	299·5

The movement of the ocean designated by the name of tide-wave, does not partake of the nature of a wave in the common acceptation of the term, but is rather to be conceived as a general movement of the water toward a point under the attracting body, and again away from it. Its periodicity is strictly dependent upon that of the attracting body. The velocity of the movement is about 1,000 miles per hour on the equator; it extends to the bottom of the ocean, the depth of which is inconsiderable compared with the radius of the earth. It is not attended by a sensible elevation of the water in mid-ocean; and, in this respect, the characteristic of what we call a wave is absent. The movement may be likened to that of an impulse given to a very long rigid bar, as of iron. In this case, a sensible time will be required for the transmission of the impulse from one end to the other, and during its transmission the particles will successively approach to each other, by which an infinitesimal elevation and subsidence, after the manner of a wave, will be produced. In the same way the transmission of the movement through the incompressible water of the sea, is attended with an infinitesimal elevation and recession; but when the movement reaches shallow water, in approaching the shores, the horizontal motion is partly translated into vertical motion upon the sloping bottom; and it is thus that the tides attain sensible vertical height. Now, where a bay or indentation of the coast presents itself, opening favorably to the tide-

* Extract from a lecture by Mr. Hilgard before the American Institute, January 27th, 1871.

wave thus developed, and decreases in width from its entrance toward its head, the tide rises higher from the mouth upward. This is due to the concentration of the wave by the approach of the shores, and to the gradual shoaling of the bottom.

This effect is strikingly illustrated by a generalization of the heights of the tides on the Atlantic coast of the United States. That coast presents, in its general outline, three large bays: the Great Southern, from Cape Florida to Cape Hatteras; the Great Middle, from Cape Hatteras to Nantucket: and the Great Eastern, from Nantucket to Cape Sable, now known as the Gulf of Maine. It will be seen that the tide-wave arrives at about the same time at the headlands, Cape Florida, Cape Hatteras, Nantucket and Cape Sable, and that at those points the height is inconsiderable compared with the rise at the head of the several bays. Thus, at Cape Florida the mean rise and fall is only one and one-half of a foot; at Hatteras, but two feet; while at the intermediate entrance to Savannah it reaches seven feet, declining in height toward both capes. Again, at the head of the Middle bay, in New York harbor, it reaches five feet, while on the southeast side of Nantucket Island it is little over one foot. The configuration of the Eastern bay is less regular, and the correspondence of heights is not so obvious. The recess of Massachusetts bay is well marked, the increase in height reaching ten feet at Boston and Plymouth. Rolling on eastward *along the coast of Maine it constantly increases.* But the most striking effect of the convergence of shores is exhibited in the bay of Fundy. At St. Johns the mean height of the tide is nineteen feet, and at Sackville, in Cumberland Basin, thirty-six feet, attaining to fifty feet and more at spring-tides.

When the wave leaves the open sea its front slope and rear slope are equal in length and similar in form, but as it advances into a narrow channel, bay or river, its front slope becomes short and steep, and its rear slope becomes long and less inclined. Hence arises the fact that at a station near the sea the time occupied by the rise is equal to that occupied by the descent; but at a station more removed from the sea the rise occupies a shorter time than the descent. Thus, in Delaware bay and river, we have the following relations of the duration and height of rise and fall.

STATION.	Mean rise and fall.	Luni-tidal interval.	MEAN DURATION OF	
			Flood tide.	Ebb tide.
	Feet.	h. m.	h. m.	h. m.
Delaware breakwater	3·5	8· 0	6·13	6· 3
Egg Island light	6·	9· 4	5·56	6·30
Newcastle	5·5	[illegible]	5·24	7· 2
Philadelphia	6·	13·44	4·52	7·24

An examination of this table will show, besides the marked increase in the height of the tide due to the contraction of the shores from the capes up to Newcastle, a subsequent loss from friction in a narrow channel of nearly uniform character, and correspondingly a rapid propagation of the tide-wave through the deep water of the bay, and a comparatively slow movement along the narrow channel of the river. At the mouth of the bay the duration of the flood tide is equal to that of the ebb, while at Philadelphia it is less by two hours forty-two minutes. When the tide is very large compared with the depth of water, this inequality becomes very great; thus, in the Severn river at Newnham, above Bristol, England, the whole rise of eighteen feet takes place in one and a half hours, while the fall occupies ten hours.

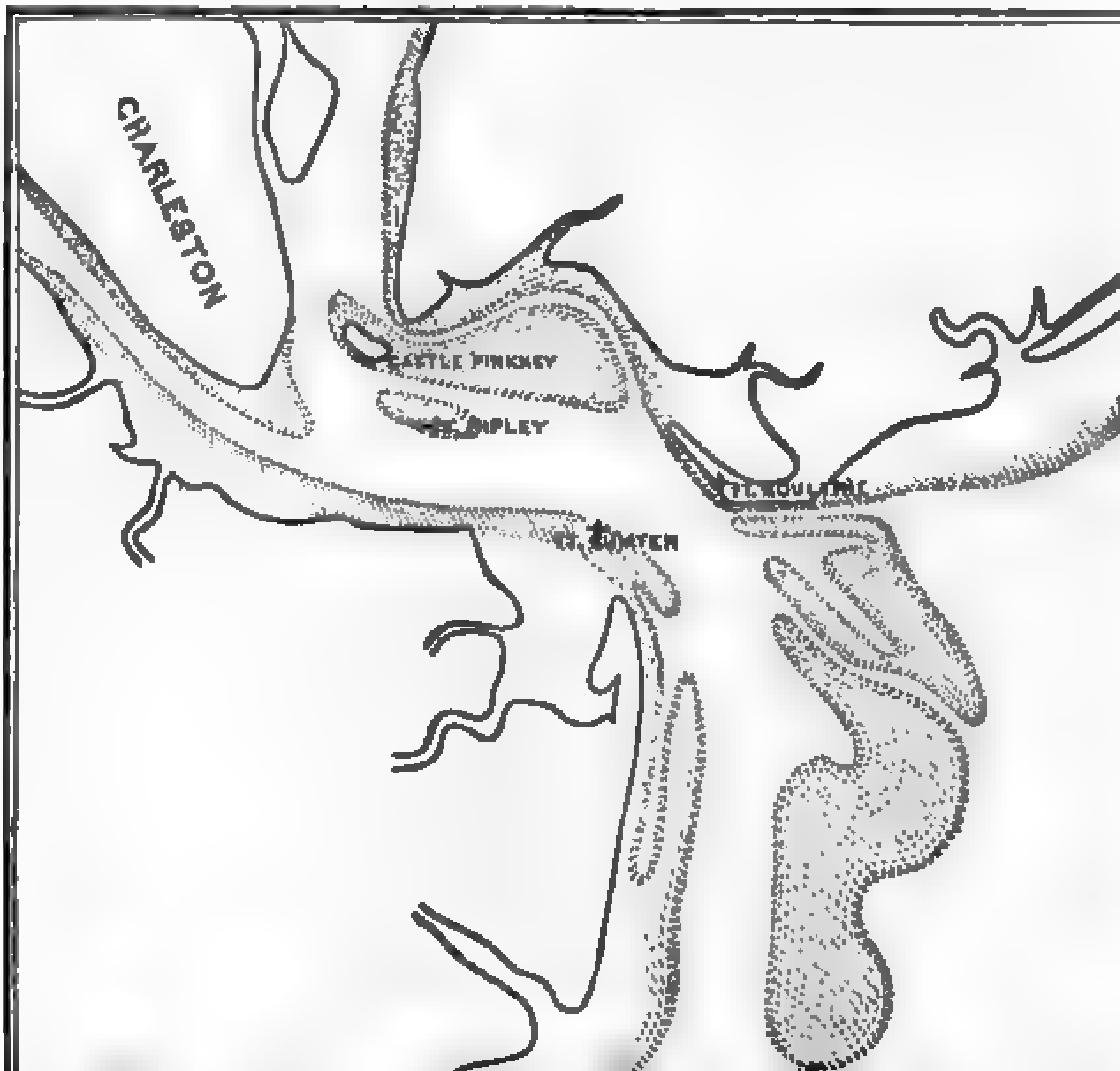
2. Tidal Currents.

The agency of tidal currents in producing changes in the entrances of bays and harbors, is a subject of the first importance to commerce and navigation, and has received full attention in the prosecution of the American Coast Survey. The laws according to which the changes takes place require to be studied by long-continued observation, and when the change is for the worse, the means of counteracting it must be pointed out.

Since on the average the same amount of water moves inward and outward with the flood and ebb tides, we might readily suppose that the same amount of material is transported either way, and that no important change would take place in the configuration of the bottom. But the operation of the flood stream is very different from that of the ebb stream. We have, as a general feature, an interior basin of some extent, communicating with the sea by a comparatively narrow passage. The flood stream, therefore, running with considerable velocity through this channel, will, as it enters the basin, spread out and become slow, depositing the sand and mud it is charged with, and making extensive flats or shoals opposite the entrance. The ebb stream runs slowly over the flats from all directions toward the opening, without removing much of the deposit, and gradually concentrates in definite narrow channels, which it scoops out, and the depth of which will depend in a great degree on the proportion of the area of the basin to the outlet, or, in other terms, on the difference of level which will be reached during the ebb between the basin and the ocean, which determines the greatest velocity and transporting power reached by the ebb stream.

On the bars of most of the sand-barred harbors on our southern coast, the place and direction of the channel are frequently

changed during violent storms, when the direction of the waves happens to be oblique to that of the channel; or, when the sea runs directly upon the channel, the depth of water



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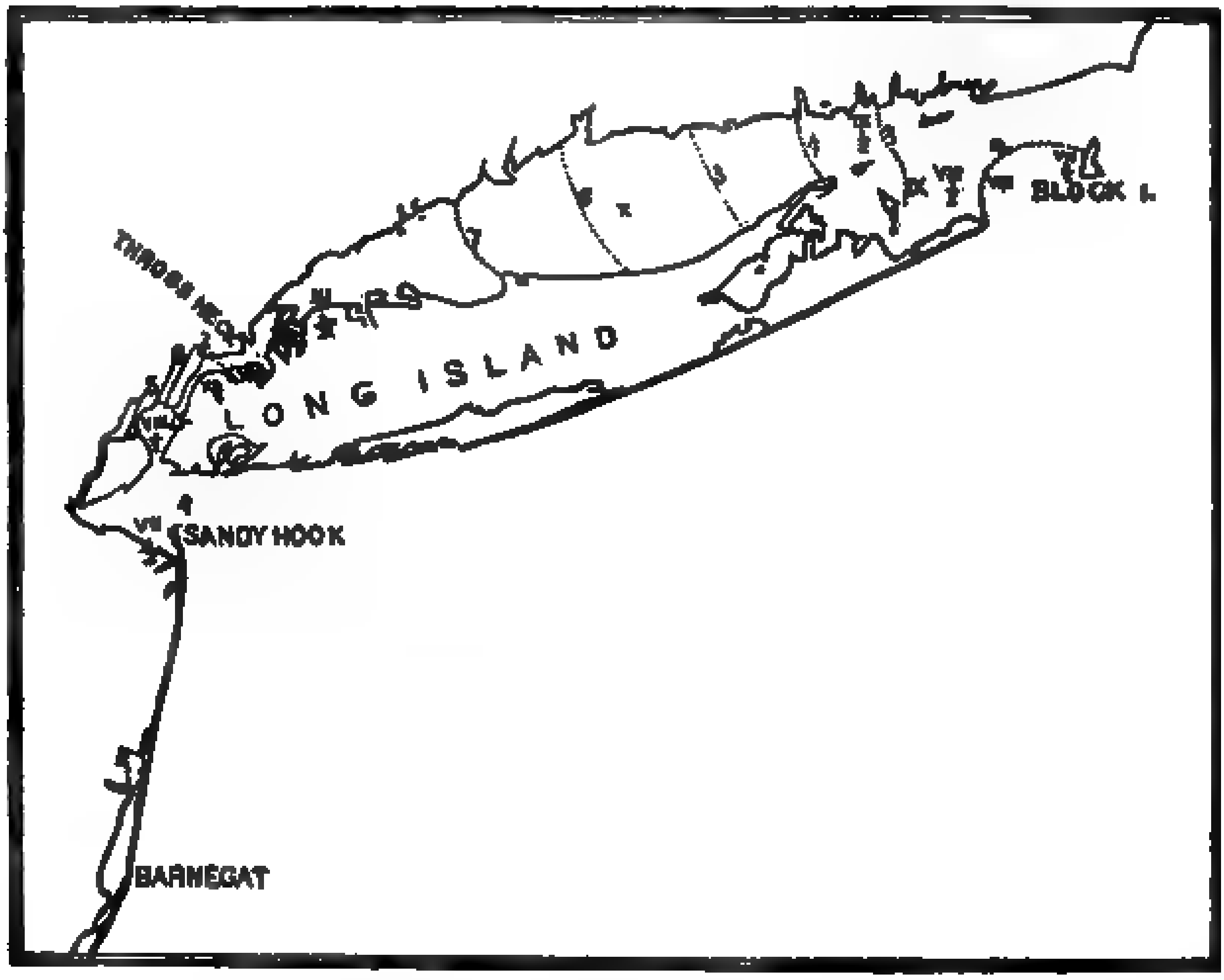
of the ebb tide, which depends upon the unchanged factors of area and form of basin, height of tide, and character of the material forming the bar.

Charleston bar.—An interesting instance of this maintenance of the depth of channels from a determinate tidal basin is furnished by the effects of the obstructions placed in the channel over Charleston bar during the war of the rebellion. On the accompanying diagram is seen the "stone fleet" sunk in the main channel, which at that time had twelve feet of water at low tide where the figure 7 indicates the present depth. There was, moreover, another channel making out more to the southward, with nine feet of water where the figure 3 indicates the present depth. The vessels were placed checkerwise in such a manner as to impede navigation while interfering least with the discharge of the water. The effect, nevertheless, was the formation of a shoal in a short time, and the scouring out of two channels, one on each side of the obstructions, through which twelve and fourteen feet can now be carried at low water. The increased water-way thus given to the ebb tide caused it to abandon the old nine foot channel on the less direct course to deep water. We have here the total obstruction of a channel, which was of considerable importance to the southward trade, by new conditions introduced at a point four miles distant from where the effect was produced; and we are warned how carefully all the conditions of the hydraulic system of a harbor must be investigated before undertaking to make any change in its natural conditions, lest totally unlooked for results be produced at points not taken into consideration.

New York Harbor and Long Island Sound.—Approaching now more closely to the consideration of the tidal conditions in New York harbor, we will examine the progress of the tide-wave through Long Island Sound from the eastward to its meeting with that entering New York bay at Sandy Hook.

We see from the following diagram that about seven and a half hours after the transit of the moon high water has advanced just within Block Island with an elevation of two feet, and, at the same time, has passed Sandy Hook with an elevation of four and a half feet. Traversing the sound at a rate indicated by the Roman figures, with increasing heights indicated by the Arabic numerals, it reaches Sands' Point eleven and a half hours after the transit of the moon with a height of seven and seven-tenths feet. The observed time of transmission from the Race to Sands' Point is two hours and one minute, and the time computed from the depths, according to the law developed by Airy, is two hours fourteen minutes; a very good approximation when we consider the irregularities in the configuration of the Sound which could not be taken into account. Advanc-

ing still farther, the height somewhat declines in consequence of the changes of direction in the channel and its shallowness.



At Hell Gate this tide-wave is met by that which had entered at Sandy Hook, and had advanced more slowly owing to the narrowness and intricacies of the channel, especially in the East river.

These two tides which meet and overlap each other at Hell Gate, differing from each other in times and heights, cause con-

[redacted]

which flow through it do not change the channel, but are obliged to follow it in its tortuous course. The Sandy Hook entrance, on the contrary, is characterized by a cordon of sands extending from Sandy Hook to Coney Island, intersected by channels, which are maintained against the action of the sea, that tends to fill them up, by the scour of the ebbtide from the tidal basin of New York harbor.

Unlike Hell Gate passage, where permanence is the leading characteristic, the bar and channels of Sandy Hook have undergone continual changes within the brief period of our history. The advance of Sandy Hook upon the main ship channel is among the notable and important instances of the effect of tidal currents. Within a century it has increased a mile and a quarter. In the place where the beacon on the end of the hook now stands there were forty feet of water fifteen years before it was built. The cause of this growth is a remarkable northwardly current along both shores of the Hook, running both during the flood and the ebb tides with varying rates, and resulting from those tides directly and indirectly.

The best water over the bar is about two miles east of Sandy Hook light, in a direct line with the Swash channel, which is the second opening, shown on the sketch, above the Hook; the shoal lying between the main or Hook channel and the Swash channel being known as Flynn's knoll. The greatest depth over the bar is twenty-two feet at mean low water; and very nearly the same depth can now be carried through the Swash channel, which formerly was three feet shallower, but has deepened since the cross section between the Hook and Flynn's knoll has been diminished by one-third its area by the growth of the Hook. This relative change in the capacity of the channels has not, however, affected the depth on the outer bar, which, according to the principles above laid down, is dependent mainly upon the area of the tidal basin within.

The depth of twenty-two feet at mean low water, which is now maintained at the entrance, through the sands constantly thrown up by the waves of the sea, may be considered as depending upon the following elements:

1st. The large basin between Sandy Hook and Staten Island, including Raritan bay, which furnishes more than one-half of the whole ebb scour.

2d. What is called the Upper bay, including the Jersey flats and Newark bay.

3d. The North river, perhaps as far as Dobb's Ferry, maintaining the head of the ebb current, although not directly taking part in the outflow; and,

4th. A portion of the Sound tide, which flows in through Hell Gate.

The proportion of the three first divisions in producing the depth of channel, may be approximately estimated by a comparison of the areas and distances from the bar. In order to maintain the depth which we now have, it is important that the area of the tidal basin should not be encroached upon. In proportion as that is diminished the depth of the channels will decrease.

The flats, just bare at low water, but covered at high tide, form as important a part as any other portion, for it is obvious that it is only the volume of water contained between the planes of low and high water, the "tide prism," that does the work in scouring the channels. The water on the flats is especially useful by retarding the outflow, thus allowing a greater difference of level to be reached between the basin and the ocean.

When we yield to the demands of commerce any portion of the tidal territory, to be used for its wharves and docks, we must do so with full cognizance of the sacrifice we are about to make in the depth of water over the bar; and in order to form any well-founded judgment in regard to the effect of such encroachments, it is necessary to be in possession of the fullest knowledge of all the physical facts involved in the problem, and no measure of encroachment should be determined upon except in pursuance of the advice of scientific experts.

A proposition, frequently mooted by men of enterprise, and resisted by those interested in the welfare of the city of New York, is the occupation of the Jersey flats, from Paulus Hook to Robbins Reef, for docks and wharves. Without expressing any opinion as to the relative value of the gain of accommodation for shipping and the loss of depth in the channel, I venture to say that the withdrawal of that area from the domain of the tide would occasion a loss of not less than one foot in the depth of the bar off Sandy Hook, and certainly not more than two feet.

The part which the fourth division in our classification of the basin of New York, that of the East river and Hell Gate passage, plays in the outflow of the ebb-tide through the Sandy Hook channels depends less upon the area involved than upon the difference in point of time and height of tide in Hell Gate already adverted to. The westerly current, usually called the ebb stream since it falls in with the ebb stream of New York harbor, taking place when the sound tide is highest, starts from a level of three and half feet higher than the easterly, and thus a much larger amount of water flows out through the Sandy Hook channels than through the narrows at Throg's Neck. It is apparent, then, that this portion of the ebb stream re-enforcing as it does the ebb stream of the harbor proper, at the most

rable times, performs a most important part in maintaining channels through the Sandy Hook bar. It may be nated that the closing of Hell Gate would cause the loss ertainly not less than three feet in the depth of those inels.

ENTRANCE TO NEW YORK HARBOR.

rom what has been said with regard to the meeting of the s in Hell Gate, it will be seen that the violent currents exenced in that locality are due to causes beyond our control. dangers to navigation arising from these currents, however, heir setting vessels upon the rocks and reefs, may, in a t measure be done away with by the removal of the obctions, in which work considerable progress has already been e. The removal of the reef at Hallett's Point, the work

upon which is now in progress, will doubtless, in a great degree, do away with the eddies and under-currents produced by the sharp turn which the channel now takes at that point. It is not improbable that the successful removal of those obstructions will yet cause the sound entrance to be used in preference to the other by the fleets plying between European ports and the great commercial metropolis of America.

NOTE.—The lecturer desires to express his indebtedness to the discussions of tides and currents by Prof. A. D. Bache and H. Mitchell, published in the reports of the U. S. Coast Survey.

ART. XIX.—*On some of the Ancient Glaciers of the Sierra Nevada;* by JOSEPH LECONTE, Professor of Geology in the University of California.

LAST summer I had again an opportunity of examining the pathways of some of the ancient glaciers of the Sierra. It will be remembered, by those interested in this subject, that two years ago I published a paper with the above title.* One of the grandest of the glaciers there mentioned was one which I called the *Lake Valley Glacier.* Taking its rise in snow fountains among the high peaks in the neighborhood of Silver Mountain, this great glacier flowed northward down Lake Valley, and, gathering tributaries from the summit ridges on either side of the valley, but especially from the higher western summits, it filled the basin of Lake Tahoe, forming a great "mer de glace," 50 miles long, 15 miles wide, and at least 2,000 feet deep, and finally escaped northeastward to the plains. The outlets of this great "mer de glace" are yet imperfectly known. A part of the ice certainly escaped by Truckee Cañon (the present outlet of the lake); a part probably went over the northeastern margin of the basin. My studies during the summer were confined to some of the larger tributaries of this great glacier.

Truckee Cañon and Donner Lake Glaciers.—I have said that one of the outlets of the great "mer de glace" was by the Truckee River Cañon. The stage road to Lake Tahoe runs in this cañon for fifteen miles. In most parts of the cañon the rocks are volcanic and crumbling, and therefore ill adapted to retain glacial marks; yet in some places where the rock is harder these marks are unmistakable. On my way to and from Lake Tahoe, I observed that the Truckee Cañon glacier was joined at the town of Truckee by a short but powerful

* This Journal, III, v, 126. Proc. Acad. Sci. Calif., IV (part 5), 259.

tributary, which, taking its rise in an immense rocky amphitheatre surrounding the head of Donner Lake, flowed eastward. Donner Lake, which occupies the lower portion of this amphitheatre, was evidently formed by the down-flowing of the ice from the steep slopes of the upper portion near the *summit.* The stage road from Truckee to the summit runs along the base of a *moraine* close by the margin of the lake on one side, while on the other side, along the apparently almost perpendicular rocky face of the amphitheatre, 1,000 feet above the surface of the lake, the Central Pacific Railroad winds its fearful way to the same place. In the upper portion of this amphitheatre large patches of snow still remain unmelted during the summer.

My examination of these two glaciers, however, was very cursory. I hasten on, therefore, to others which I traced more carefully.

As already stated in my former paper, Lake Tahoe lies countersunk on the very top of the Sierra. This great range is here divided into two summit ridges, between which lies a trough 50 miles long, 20 miles wide, and 3,000–3,500 feet deep. This trough is Lake Valley. Its lower half is filled with the waters of Lake Tahoe. The area of this lake is about 250 square miles, its depth 1,640 feet, and its altitude 6,200 feet. It is certain that during the fullness of Glacial times this trough was a great "mer de glace," receiving tributaries from all directions except the north. But as the Glacial period waned—as the great "mer de glace" dwindled and melted away, and the lake basin became occupied by water instead, the tributaries still remained as separate glaciers flowing into the lake. The tracks of these lingering smaller glaciers are far more easily traced and their records more easily read, than are those of the greater but more ancient glacier of which they were once but the tributaries.

Of the two summit ridges mentioned above the western is the higher. It bears the most snow *now*, and in glacial times gave origin to the grandest glaciers. Again: the peaks on both these summits rise higher and higher as we go toward the upper or southern end of the lake. Hence the largest glaciers ran into the lake at its *southwestern* end. And, since the mountain slopes here are toward the northeast and therefore the shadiest and coolest, here also the glaciers have had the greatest vitality and lived the longest, and have, therefore, left the plainest record. Doubtless, careful examination would discover the pathways of glaciers running into the lake from the eastern summit also; but I failed to detect any very clear traces of such, either on the eastern or on the northern portion of the western side of the lake; while between the southwestern

end and Sugar Pine Point, a distance of only eight or ten miles, I saw distinctly the pathways of five or six. North of Sugar Pine Point there are also several. *They are all marked by moraine ridges running down from the summits and projecting as points into the lake.* The pathways of three of these glaciers I studied somewhat carefully, and after a few preliminary remarks, will describe in some detail.

Mountains are the culminating points of the scenic grandeur and beauty of the earth. They are so, because they are also the culminating points of all geological agencies—igneous agencies in mountain *formation*, aqueous agencies in mountain *sculpture*. Now, I have already said that the mountain peaks which stand above the lake on every side are highest at the southwestern end, where they rise to the altitude of 3,000 feet above the lake surface, or between 9,000 and 10,000 feet above the sea. Here, therefore, ran in the greatest glaciers; here we find the profoundest glacial sculpturings; and here also are clustered all the finest beauties of this the most beautiful of mountain lakes. I need only name Mt. Tallac, Fallen Leaf Lake, Cascade Lake, and Emerald Bay, all within three or four miles of each other and of the Tallac House. These three exquisite little lakes (for Emerald Bay is also almost a lake), nestled closely against the loftiest peaks of the western summit ridge, are all perfect examples of glacial lakes.

South of Lake Tahoe, Lake Valley extends for fifteen miles as a plain, gently rising southward. At its lower end it is but a few feet above the lake surface, covered with glacial drift modified by water, and diversified, especially on its western side, by débris ridges, the moraines of glaciers which continued to flow into the valley or into the lake long after the main glacier, of which they were once tributaries, had dried up. On approaching the south end of the lake by steamer, I had observed these long ridges, divined their meaning, and determined on a closer acquaintance. While staying at the Tallac House I repeatedly visited them and explored the cañons down which their materials were brought. I proceed to describe them.

Fallen Leaf Lake Glacier.—Fallen Leaf Lake (see map, p. 130) lies on the plain of Lake Valley, about one and a half miles from Lake Tahoe, its surface but a few feet above the level of the latter lake, but its bottom far, probably several hundred feet, below that level. It is about three to three and one-half miles long and one and one-fourth miles wide. From its upper end runs a cañon bordered on either side by the highest peaks in this region. The rocky walls of this cañon terminate on the east side at the head of the lake, but on the west side, a little farther down. The lake is bordered on each side by an ad-

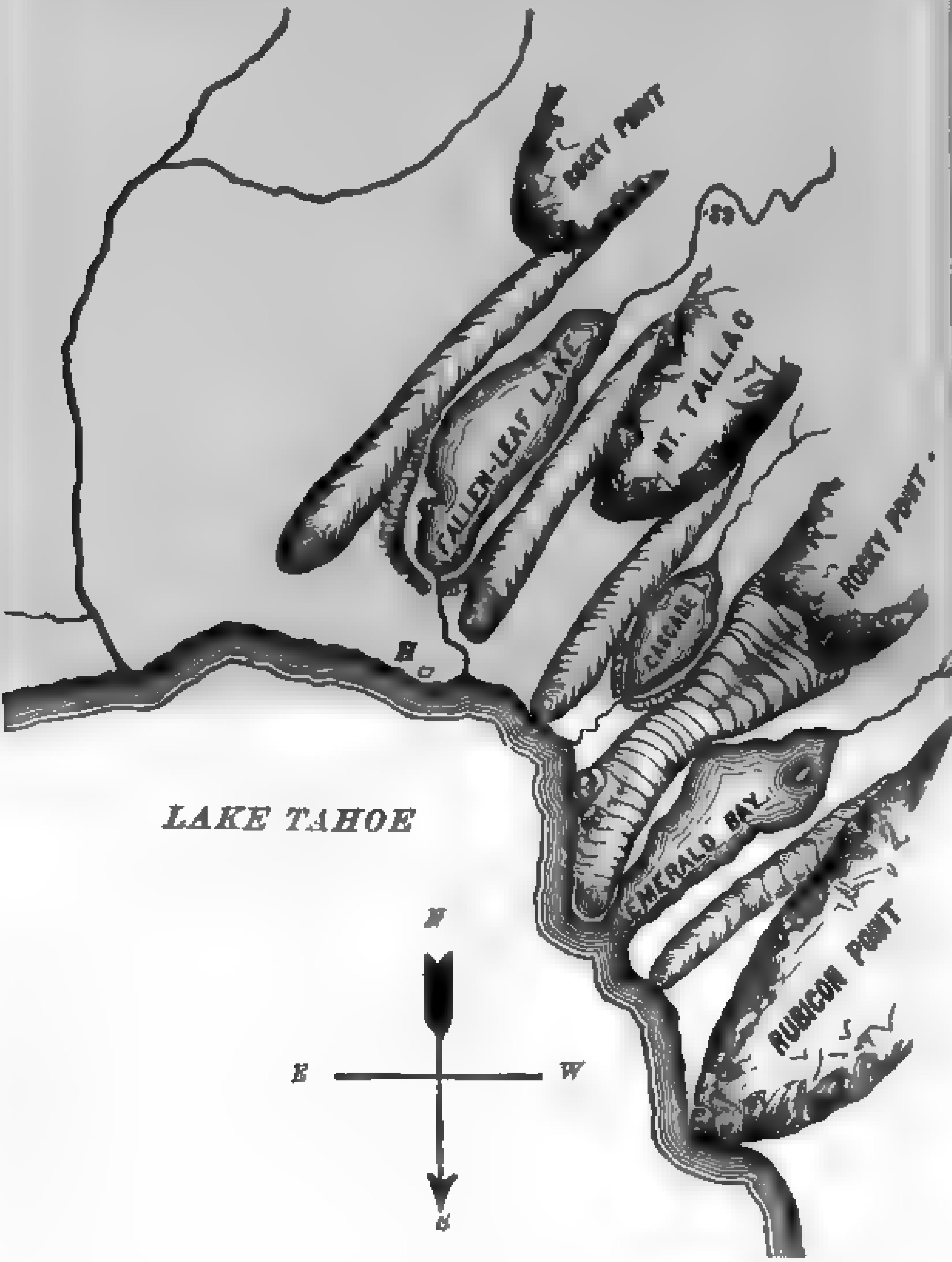
mirably marked débris ridge (moraine) three hundred feet high, four miles long, and one and one-half to two miles apart. These moraines may be traced back to the termination of the rocky ridges which bound the cañon. On one side the moraine lies wholly on the plain; on the other side its upper part lies against the slope of Mt. Tallac. Near the lower end of the lake a somewhat obscure branch ridge comes off from each main ridge, and curving around it forms an imperfect terminal moraine through which the outlet of the lake breaks its way.

On ascending the cañon the glaciation is very conspicuous, and becomes more and more beautiful at every step. From Soda Springs (map, *ss*) upward it is the most perfect I have ever seen. In some places the whole rocky bottom of the cañon, for many acres in extent, is smooth and polished and gently undulating, like the surface of a glassy but billowy sea. The glaciation is distinct also up the sides of the cañon 1,000 feet above its floor.

There can be no doubt, therefore, that a glacier once came down this cañon filling it 1,000 feet deep, scooped out Fallen Leaf Lake just where it struck the plain and changed its angle of slope, and pushed its snout four miles out on the level plain, nearly to the present shores of Lake Tahoe, dropping its débris on either side and thus forming a bed for itself. In its subsequent retreat it seems to have rested its snout some time at the lower end of Fallen Leaf Lake, and accumulated there an imperfect terminal moraine. The outlines of this little lake with its bordering moraines are shown in the diagram-map on the following page.

2. *Cascade Lake Glacier.*—Cascade Lake, like Fallen Leaf Lake, is about one and one-half miles from Lake Tahoe, but, unlike Fallen Leaf Lake, its discharge creek has considerable fall, and the lake surface is, therefore, probably 100 feet above the level of the greater lake. On either side of this creek, from the very border of Lake Tahoe, runs a moraine ridge up to the lake, and thence close along each side of the lake up to the rocky points which terminate the true mountain cañon above the head of the lake. I have never anywhere seen more perfectly defined moraines. I climbed over the larger western moraine and found that it is partly merged into the eastern moraine of Emerald Bay to form a medial at least 300 feet high, and of great breadth (see map). From the surface of the little lake the curving branches of the main moraine, meeting below the lake to form a terminal moraine, are very distinct. At the head of the lake there is a perpendicular cliff over which the river precipitates itself, forming a very pretty cascade of 100 feet or more. On ascending the cañon above the head of the lake,

for several miles, I found, everywhere, over the lip of the precipice, over the whole floor of the cañon, and up the sides 1,000 feet or more, the most perfect glaciation.



There cannot, therefore, be the slightest doubt that this also is the pathway of a glacier which once ran into Lake Tahoe. After coming down its steep rocky bed, this glacier precipitated itself over the cliff, scooped out the lake at its foot, and then ran on until it bathed its snout in the waters of Lake Tahoe,

ıd probably formed icebergs there. In its subsequent retreat seems to have dropped more débris in its path and formed more perfect terminal moraine than did Fallen Leaf Lake lacier.

Emerald Bay Glacier.—All that I have said of Fallen Leaf ıke and Cascade Lake apply, almost word for word, to nerald Bay. This beautiful bay, almost a lake, has also en formed by a glacier. It also is bounded on either side moraines, which run down to and even project into Lake ıhoe, and may be traced up to the rocky points which form e mouth of the cañon at the head of the bay. Its eastern oraine, as already stated, is partly merged into the western oraine of Cascade Lake, to form a huge medial moraine. Its estern moraine lies partly against a rocky ridge which runs wn to Lake Tahoe to form Rubicon Point. At the head of e bay, as at the head of Cascade Lake, there is a cliff about 0 feet high, over which the river precipitates itself and forms beautiful cascade. Over the lip of this cliff, and in the bed the cañon above, and up the sides of the cliff-like walls,)00 feet or more, the most perfect glaciation is found. The ly difference between this glacier and the two preceding is, at it ran more deeply into the main lake and the deposits opped in its retreat did not rise high enough to cut off its tle rock basin from that lake, but exists now only as a *allow bar* at the mouth of the bay. This bar consists of *ıe moraine matter*, i. e., intermingled boulders and sand, ıich may be examined through the exquisitely transparent ıter almost as perfectly as if no water were present. Some the boulders are of large size.

All that I have described separately and in detail, and much ore, may be taken in at one view from the top of Mt. Tallac. om this peak nearly the whole course of these three glaciers, eir fountain amphitheatres, their cañon beds, and their lakes closed between their moraine arms, may be seen at once. ıe view from this peak is certainly one of the finest I have er seen. Less grand and diversified in mountain forms than ıny from peaks above the Yosemite, it has the added beauty extensive water surface, and the added interest of several ıcial pathways in a limited space. The observer sits on the ry edge of the fountain amphitheatres still holding large ısses of snow; immediately below, almost at his feet, lie istening, gem-like, in dark rocky setting, the three exquisite tle lakes: on either side of these, embracing and protecting em, stretch out the moraine arms, reaching toward and recting the eye to the great lake, which lies, map-like, with l its sinuous outlines perfectly distinct, even to its extreme ırthern end, twenty-five to thirty miles away. As the eye

sweeps again up the cañon-beds, little lakes, glacier scooped rock basins, filled with ice-cold water, flash in the sunlight on every side. Twelve or fifteen of these may be seen.

From appropriate positions on the surface of Lake Tahoe, also, all the moraine ridges are beautifully seen at once, but the glacial lakes and the cañon beds, of course, cannot be seen. I have attempted, in the rough sketch accompanying this paper, to express the combined results of observations from many points. The outlines of the great and small lakes are accurate, as these have been taken from reliable maps. Also the general position of the rocky points, and the moraine ridges, are tolerably correct. But, otherwise, the sketch is intended as an illustrative diagram rather than a topographical map. The view is supposed to be taken from an elevated position above the lake surface, looking southward.

There are several questions of a general nature suggested by my examination of these three glacial pathways, which I have thought best to consider separately.

a. Evidences of the existence of the Great Lake Valley Glacier.—In my former paper I have already given some evidence of the former existence of this glacier in the glacial forms detectable in the upper part of this valley. I will now give some additional evidence, gathered last summer.

On the south shore of Lake Tahoe, and especially at the northern or lower end of Fallen Leaf Lake, I found many pebbles and some large boulders of a beautiful striped agate-like slate. The stripes consisted of alternate bands of black and translucent white, the latter weathering into milk-white, or yellowish, or reddish. It was perfectly evident that these fragments were brought down from the cañon above Fallen Leaf Lake. On ascending this cañon I easily found the parent rock of these pebbles and boulders. It is a powerful outcropping ledge of beautifully striped siliceous slate, full of fissures and joints, and easily broken into blocks of all sizes, crossing the cañon about a half mile above the lake. This rock is so peculiar and so easily identified that its fragments become an admirable index of the extent of the glacial transportation. I have, myself, traced these pebbles only a little way along the western shores of the great lake, as my observations were principally confined to this part; but I learn from my brother, Professor John LeConte, and from Mr. John Muir, both of whom have examined the pebbles I brought home, that precisely similar fragments are found in great abundance all along the western shore from Sugar Pine Point northward, and especially on the extreme northwestern shore nearly thirty miles from their source. I have visited the eastern shore of the lake somewhat more extensively than the western, and

nowhere did I see similar pebbles. Mr. Muir, who has walked around the lake, tells me that they do not occur on the eastern shore. We have, then, in the distribution of these pebbles, demonstrative evidence of the fact that Fallen Leaf Lake glacier was once a tributary of a much greater glacier which filled Lake Tahoe.

The only other agency to which we could attribute this transportation is that of shore ice and icebergs, which probably did once exist on Lake Tahoe; but the limitation of the pebbles to the western, and especially the northwestern shores, is in exact accordance with the laws of glacial transportation, but contrary to those of floating ice transportation—for lake ice is carried only by winds, and would, therefore, deposit equally on all shores.

Again: I think I find additional evidence of a Lake Tahoe "mer de glace" in the contrasted character of the northern and southern shores of this lake.

All the little glacial lakes described above are deep at the upper end and shallow at the lower end. Further, all of them have a sand beach and a sand flat at the upper end, and great boulders thickly scattered in the shallow water, and along the shore at the lower end. These facts are easily explained, if we remember that while the glacial *scooping* was principally at the upper end, the glacial *droppings* were principally at the lower end. And further: that while the *glacial* deposit was principally at the lower end, the *river* deposit, since the glacial epoch, has been wholly at the upper end.

Now the great lake, also, has a similar structure. It also has a beautiful sand and gravel beach all along its upper shore, and a sand flat extending above it; while at its lower, or northern end, thickly strewed in the shallow water, and along the shore line, and some distance above the shore line, are found in great abundance *boulders of enormous size.* May we not conclude that similar effects have been produced by similar causes—that these huge boulders were dropped by the great glacier at its lower end? Similar boulders are also found along the northern portion of the eastern shore, because the principal flow of the ice-current was from the southwest, and in the fullness of glacial times the principal exit was over the northeastern lip of the basin.

b. Origin of Lake Tahoe.—That Lake Tahoe was once wholly occupied by ice, I think, is certain; but that it was scooped out by Lake Valley glacier is perhaps more doubtful. All other Sierra lakes which I have seen certainly owe their origin to glacial agency. Neither do I think we should be staggered by the size or enormous depth of this lake. Yet, from its position, it may be a plication-hollow, or a trough produced by the

formation of two parallel mountain ridges, and afterward modified by glacial agency, instead of a pure glacial-scooped rock-basin. In other words, Lake Valley, with its two summit ridges, *may well be regarded as a phenomenon belonging to the order of mountain-formation and not to the order of mountain sculpture.* I believe an examination of the rocks of the two summit ridges would probably settle this. In the absence of more light than I now have, I will not hazard an opinion.

c. Passage of slate into granite.—From the commencement of the rocky cañon at the head of Fallen Leaf Lake, and up for about two miles, the cañon walls and bed are composed of *slate.* The slate, however, becomes more and more metamorphic as we go up, until it passes into what much resembles *trap.* In some places it looks like *diorite* and in others like *porphyry.* I saw no evidence, however, of any outburst. This latter rock passes somewhat more rapidly into *granite* at Soda Springs. From this point the cañon bed and lower walls are granite, but the highest peaks are still a dark, splintery, metamorphic slate. The glacial erosion has here cut through the slate and bitten deep into the underlying granite. The passage from slate through porphyritic diorite into granite may, I think, be best explained by the increasing degree of metamorphism, and at the same time a change of the original sediments at this point; granite being the last term of metamorphism of pure clays, or clayey sandstones, while bedded diorites are similarly formed from ferruginous and calcareous slates. Just at the junction of the harder and tougher granite with the softer and more jointed slates, occur, as might be expected, cascades in the river. It is probable that the cascades at the head of Cascade Lake and Emerald Bay mark, also, the junction of the granite with the slate—only the junction here is covered with débris. Just at the same junction, in Fallen Leaf Lake Cañon, burst out the waters of Soda Springs, highly charged with bicarbonates of iron and soda.

d. Glacial Deltas.—I have stated that the moraines of Cascade Lake and Emerald Bay glaciers run down to the margin of Lake Tahoe. An examination of this portion of the lake shore shows that *they ran far into the lake*—that the lake has been filled in, two or three miles, by glacial débris. On the eastern margin of Lake Tahoe, the water, close along the shore, is comparatively shallow, the shore rocky, and along the shore-line, above and below the water. are scattered great boulders, probably dropped by the main glacier. But on the west margin of the lake the shore-line is composed wholly of moraine matter, the water very deep close to shore, and the bottom composed of precisely similar moraine matter. In rowing along the shore, I found that the exquisite ultramarine

blue of the deep water extends to within 100 to 150 feet of the shore-line. At this distance, the bottom could barely be seen. Judging from the experiments of my brother, Professor John LeConte, according to which a white object could be seen at a depth of 115 feet, I suppose the depth along the line of junction of the ultramarine blue and the emerald green water is at least 100 feet. The slope of the bottom is, therefore, nearly, or quite, 45°. It seems, in fact, a direct continuation beneath the water of the moraine slope. The materials, also, which may be examined with ease through the wonderfully transparent water, are exactly the same as that composing the moraine, viz: earth, pebbles, and boulders of all sizes, some of them of enormous dimensions. It seems almost certain that *the margin of the great Lake Valley glacier, and of the lake itself when this glacier had melted and the tributaries first began to run into the lake, was the series of rocky points at the head of the three little lakes, about three or four miles back from the present margin of the main lake; and that all lakeward from these points has been filled in and made land by the action of the three glaciers described.* At that time Rubicon Point was a rocky promontory, projecting far into the lake, beyond which was another wide bay, which has been similarly filled in by débris brought down by glaciers north of this point. The long moraines of these glaciers are plainly visible from the lake surface; but I have not examined them. Thus, all the land, for three or four miles back from the lake-margin, both north and south of Rubicon Point, is composed of *confluent glacial deltas*, and on these deltas the moraine ridges are the *natural levées* of these ice-streams.

e. Parallel Moraines.—The moraines described above are peculiar and almost unique. Nowhere, except about Lake Tahoe and near Lake Mono, have I seen moraines in the form of *parallel ridges* lying on a level plain and terminating abruptly *without any signs of transverse connection* (*terminal moraine*) *at the lower end.* Nor have I been able to find any description of similar moraines in other countries. They are not terminal moraines, for the glacial pathway is open below. They are not lateral moraines, for these are borne on the glacier itself, or else stranded on the steep cañon sides. Neither do I think moraines of this kind would be formed by a glacier emerging from a steep narrow cañon and running out on a level plain; for in such cases, as soon as the confinement of the bounding walls is removed, the ice stream spreads out into an *ice lake.* It does so as naturally and necessarily as does water under similar circumstances. The deposit would be nearly transverse to the direction of motion, and, therefore, more or less crescentic. There must be something peculiar in the conditions under

which these parallel ridges were formed. I believe the conditions were as described below.

We have already given reason to think that the original margin of the lake, in Glacial times, was three or four miles back from the present margin, along the series of rocky points against which the ridges abut; and that all the flat plain thence to the present margin is made land. If so, then it is evident that at that time the three glaciers described ran far out into the lake, until reaching deep water, where they formed icebergs. Under these conditions, it is plain that the pressure on this, the subaqueous portion of the glacial bed, would be small, and become less and less until it becomes nothing at the point where the icebergs float away. The pressure on the bed being small, not enough to overcome the cohesion of ice, there would be no spreading. *A glacier running down a steep narrow cañon and out into deep water, and forming icebergs at its point, would maintain its slender, tongue-like form, and drop its débris on each side, forming parallel ridges, and would not form a terminal moraine because the materials not dropped previously would be carried off by icebergs.* In the subsequent retreat of such a glacier, imperfect terminal moraines might be formed higher up, where the water is not deep enough to form icebergs. It is probable, too, that since the melting of the great "mer de glace" and the formation of the lake, the level of the water has gone down considerably, by the deepening of the Truckee Cañon outlet by means of erosion. Thus not only did the glaciers retreat from the lake, but also the lake from the glaciers.

As already stated, similar parallel moraine ridges are formed by the glaciers which ran down the steep eastern slope of the Sierras, and out on the level plains of Mono. By far the most remarkable are those formed by Bloody Cañon Glacier, as described in my former paper. These moraines are six or seven miles long, 300 to 400 feet high, and the parallel crests not more than a mile asunder. There, also, as at Lake Tahoe, we find them terminating abruptly in the plain without any sign of terminal moraine. But higher up there are small, imperfect, transverse moraines, made during the subsequent retreat, behind which water has collected, forming lakes and marshes. But observe: these moraines are also *in the vicinity of a great lake;* and we have abundant evidence, in very distinct terraces described by Whitney* and observed by myself, that in glacial times the *water stood at least six hundred feet above the present level.* In fact, there can be no doubt that at that time the waters of Mono Lake (or a much greater body of water of which Mono is the remnant) washed against the bold rocky points from which the débris ridges start. *The glaciers*

* Geological Survey of California, vol. i, 451.

in this vicinity, therefore, must have run out into the water six or seven miles, and doubtless formed icebergs at their point, and, therefore, formed there no terminal moraine.

That the glaciers described about Lake Tahoe and Lake Mono ran out far into the water and formed icebergs I think is quite certain, and that parallel moraines open below are characteristic signs of such conditions I also think nearly certain.

f. Glacial Erosion.—My observations on glacial pathways in the high Sierra, and especially about Lake Tahoe, have greatly modified my views as to the nature of glacial erosion. Writers on this subject seem to regard glacial erosion as mostly, if not wholly, a *grinding* and *scoring;* the débris of this erosion as rock-meal; the great boulders, which are found in such immense quantities in the terminal deposit, as derived wholly from the crumbling cliffs above the glacial surface; the *rounded* boulders, which are often the most numerous, as derived in precisely the same way, only they have been engulfed by crevasses, or between the sides of the glacier and the bounding wall, and thus carried between the moving ice and its rocky bed, as between the upper and nether millstone. In a word, all boulders, whether angular or rounded, are supposed to owe their *origin* or *separation* from their parent rock to atmospheric agency, and only their *transportation* and *shaping* to glacial agency.

Now, if such be the true view of glacial erosion, evidently its effect in mountain sculpture must be small indeed. *Roches moutonneés* are recognized by all as the most universal and characteristic sign of a glacial bed. Sometimes these beds are only imperfectly *moutonneés,* i. e., they are composed of *broken angular surface with only the points and edges planed off.* Now, *moutonneés* surfaces always, and especially angular surfaces with only points and edges beveled, show that the erosion by grinding has been only very superficial. They show that if the usual view of glacial erosion be correct, the great cañons, so far from being *formed,* were only *very slightly modified* by glacial agency. But I am quite satisfied, from my own observations, that this is not the only *nor the principal* mode of glacial erosion. I am convinced that a glacier, by its enormous pressure and resistless onward movement, is *constantly breaking off large blocks* from its bed and bounding walls. Its erosion is not only a grinding and scoring, but also a *crushing and breaking.* It makes by its erosion not only rock-meal, but also large *rock-chips.* Thus, a glacier is constantly breaking off blocks and making angular surfaces, and then grinding off the angles both of the fragments and the bed, and thus forming rounded boulders and *moutonneés* surfaces. Its erosion is a

constant process of alternate *rough hewing* and *planing*. If t rock be full of fissures, and the glacier deep and heavy, t rough hewing so predominates that the plane has only time touch the corners a little before the rock is again broken a new angles formed. This is the case high up on the *cañ walls*, at the head of Cascade Lake and Emerald Bay, but al in the *cañon beds wherever the slate is approached.* If, on t other hand, the rock is very hard and solid, and the glacier not very deep and heavy, the planing will predominate ov the rough hewing, and a smooth, gentle billowy surface is t result. This is the case in the hard granite forming the be of all the cañons high up, but especially high up the cañon Fallen Leaf Lake, where the cañon spreads out, and extensi but comparatively thin snow sheets have been at work. some cases *on the cliffs*, subsequent disintegration of a glaci polished surface may have given the appearance of angul surfaces with beveled corners; but, in other cases, in the *bed the cañon*, and on elevated level places, where large loosen blocks could not be removed by water nor by gravity, I c served the same appearances, under conditions which forb this explanation. Mr. Muir, also, in his Studies in the Sier gives many examples of undoubted rock-breaking by ancie glaciers.

Angular blocks are mostly, therefore, the ruins of crumbli cliffs, borne on the surface of the glacier and deposited at foot. Many *rounded* boulders also have a similar origin, havi found their way to the bed of the glacier through crevasses, along the sides of the glacier. But *most of the rounded bould* in the terminal deposit of *great glaciers* are fragments *torn off the glacier itself.* The proportion of angular to rounded boul ers—of upper or air-formed to nether or glacier-formed fra ments, depends on the depth and extent of the ice-current. the case of the universal ice-sheet (ice-flood) there are, course, no upper formed or angular blocks at all—there nothing borne on the surface. The moraine, therefore, consis wholly of nether-formed and nether-borne .severely triturat materials (*moraine profonde*). The boulders are, of course, a rounded. This is one extreme. In the case of the thin movi ice-fields, the *glacierets* which still linger among the highest pea and shadiest hollows of the Sierra, on the other hand, the m raines are composed *wholly of angular blocks*. This is t character of the terminal moraine of Mt. Lyell glacier, d scribed in my previous paper. These glacierets are too th and feeble and torpid to break off fragments—they can on *bear* away what falls on them. This is the other extrem But in the case of ordinary glaciers—*ice streams*—the bould of the terminal deposit are mixed; the angular or upper-form

predominating in the small existing glaciers of temperate climates, but the rounded or nether-formed greatly predominating in the grand old glaciers of which we have been speaking. In the terminal deposits of these, especially in the materials pushed into the lake, it is somewhat difficult to find a boulder which has not been subjected to severe attrition.

ART. XX.—*Certain Methyl and Benzyl Compounds containing Selenium;* by C. LORING JACKSON.

METHYL COMPOUNDS.

Methyl Monoselenide $(CH_3)_2Se$.—The only previous research on this compound is one by Wöhler and Dean,* but it is evident from the properties and oxidation product described by them, that they obtained the methyl diselenide $(CH_3)_2Se_2$, and not the methyl monoselenide $(CH_3)_2Se$. In fact Rathke, some years later,† showed that in the ethyl series their process yielded principally $(C_2H_5)_2Se_2$, and but a comparatively small quantity of $(C_2H_5)_2Se$. Under the direction of Professor Hofmann, in the Berlin Laboratory, I have prepared the methyl monoselenide according to the process by which Rathke succeeded in obtaining ethyl monoselenide, and find that it differs entirely from the substance described under that name by Wöhler and Dean, but is analogous to $(C_2H_5)_2Se$ prepared by Joy ‡ and Rathke. Further, I find that in the benzyl series this process yields $(C_7H_7)_2Se$, while that adopted by Wohler and Dean yields principally $(C_7H_5)_2Se_2$.

Methyl Monoselenide $(C_4H_3)_2Se$ was prepared by distilling a mixture of strong solutions of NaOH and CH_3KSO_4 with P_2Se_5. The product freed from water was purified by fractional distillation.

	Calculated for $(CH_3)_2Se$.§	Observed.
Carbon	22·22	22·07
Hydrogen	5·55	5·51

It is a colorless liquid with a brilliant luster and most offensive odor. Boiling point 58·2° (uncorr.). It burns with a blue selenium flame, is heavier than water and does not mix with it; when moist it turns yellow, probably from formation of $(CH_3)_2Se_2$; by boiling with water it is decomposed, selenium being set free. It mixes with alcohol and ether, is not affected by hydrochloric acid or sodic hydrate solution, but dissolves in strong nitric acid, forming

* Ann. Chem. Pharm., xcvii, p. 1. † Ibid, clii, p. 208. ‡ Ibid, lxxxvi, p. 36.
§ The atomic weight used for Se was 78, that given by Lothar Meyer in his Moderne Theorien der Chemie.

Nitrate of Methyl Selenide.—This substance can be purified by recrystallization from pure water or alcohol. Its formula is either $(CH_3)_2Se(NO_3)OH$ or $(CH_3)_2Se(NO_3).(CH_3)_2SeO$, but the percentages from these two formulæ are so nearly the same, that it was imposible to decide from the analysis which was the right one. It crystallizes in long white prisms with a slight odor, which melt at 90·5° (uncorr.), and are extremely soluble in water, less so in alcohol, but freely soluble in hot, insoluble in ether.

Chloride of Methyl Selenide $(CH_3)_2SeCl_2$ was formed by precipitating the nitrate with hydrochloric acid. It can be purified by crystallization from alcohol.

	Calculated for $(CH_3)_2SeCl_2$.	Observed.	
Chlorine	39·66	39·02	38·82

It forms large white very thin scales with a pearly luster and disagreeable odor. Melting point 59·5° (uncorr.). It is slightly soluble in water and ether, very soluble in alcohol and in hydrochloric acid.

Bromide of Methyl Selenide $(CH_3)_2SeBr_2$ was prepared like the chloride using hydrobromic instead of hydrochloric acid. The yellow precipitate was washed with cold water and recrystallized once out of hot alcohol.

	Calculated for $(CH_3)_2SeBr_2$.	Observed.
Bromine	59·70	59·95

It forms very thin sulphur-yellow crystalline plates, with a pearly luster and very disagreeable odor, melts under decomposition at 82° (uncorr.); is less soluble in water than the chloride, not very soluble in cold alcohol; when heated with alcohol a portion dissolves, the rest melts to a dark brown oil, which on cooling suddenly crystallizes in yellow scales, swelling very much and giving off methylselenide, which was recognized by its odor, the supernatant alcohol becomes brown. It would seem that the compound was disassociated according to the following reaction:

$$(CH_3)_2SeBr_2=(CH_3)_2Se+Br_2,$$

and that on cooling it was regenerated, while the heat given off by the combination volatilized a portion of the methylselenide, and the bromine thus left free colored the alcohol brown. This view is supported by the fact that $(CH_3)_2SeBr_2$ can be made by direct combination of $(CH_3)_2Se$ and bromine, much heat being evolved in the process. On account of this property, crystallization of the bromide of methylselenide from alcohol is always attended with loss. The substance is insoluble in ether.

Iodide of Methyl Selenide $(CH_3)_2SeI_2$ was formed when aque-

solutions of the nitrate and potassic iodide were mixed. : red precipitate was washed with water and alcohol. Only roximate results were obtained on analysis, as, owing to the it instability of the substance it was impossible to obtain it 'ectly pure. It is a brick-red powder, which even in vacuo lually decomposes, iodine being set free. It is insoluble in er, quite soluble in alcohol and ether, but its solutions are ipletely decomposed even by spontaneous evaporation, so ; no crystals could be obtained. The substance breaks up, the same way as the bromide, into methylselenide and ne.

'arious attempts to prepare the oxide $(CH_3)_2SeO$ by treat- $(CH_3)_2SeCl_2$ with Ag_2O were unsuccessful, as the argentic ıride formed blackened almost immediately from formation rgentic selenide. The cyanide $(CH_3)_2Se(CN)_2$ seems to be emely unstable. I did not succeed in preparing it in a a fit for examination, either by the action of KCN on the ate or of AgCN on the chloride. A sulphate, probably $._3)_2SeSO_4$, was prepared by the action of argentic sulphate the chloride, but was not investigated.

fethyl Selenide Platinic Chloride $[(CH_3)_2Se]_2PtCl_4$.—When hyl selenide is poured into an aqueous solution of platinic ıride a pale red precipitate is formed, which boiled with er becomes suddenly bright lemon yellow—the change of r is very striking—and can then be crystallized from a large ntity of hot alcohol by slow evaporation. The crystals e washed with cold alcohol, and the platinum determined gnition; as with all other platinum compounds containing nium, very long-continued ignition over the blast-lamp was essary to drive off the last traces of selenium.

	Calculated for $[(CH_3)_2Se]_2PtCl_4$.	Observed.	
Platinum	35·54	35·48	....
Carbon	8·64	....	8·94
Hydrogen	2·16	....	2·42

; crystallizes in minute yellow plates made up of pennate ıps of needles; when ignited below redness it gives off hylselenide and turns black; is very slightly soluble in er, sparingly soluble in hot alcohol, insoluble in ether.

BENZYL COMPOUNDS.

Benzyl Monoselenide $(C_6H_5CH_2)_2Se$.—Sodic monoselenide ned by the action of phosphoric pentaselenide on alcoholic ı was boiled with benzyl chloride in a flask with a return- ler. The liquid gave on cooling, white needles of benzyl ıoselenide, followed by yellow scales of benzyl diselenide, two substances were separated by recrystallization from

alcohol. It saves time to make a first rough separation with ether, in which the monoselenide is the most soluble.

Calculated for $(CH_7)_2Se$.		Observed.	
Carbon	64·62	63·15	63·73
Hydrogen	5·38	5·54	5·56

If an excess of benzyl chloride is used, a yellow oily liquid is obtained, which after some time deposits the benzyl monoselenide in large well-formed flat prisms apparently belonging to the monoclinic system. These, as well as the white needles deposited by the alcoholic solution, melt at 45·°5 (uncorr.) and burn with a smoky flame, which shows the blue color characteristic of selenium. It has very little odor, is insoluble in water, freely soluble in alcohol and ether.

It seems to form salts analogous to those of the methyl selenide, but owing to their great instability and the difficulty of preparing benzyl monoselenide I was unable to get enough for analyses, and therefore cannot give their formulæ.

Nitrate of Benzyl Selenide.—Benzyl monoselenide was converted by heating gently with strong nitric acid into a white mass, which formed on crystallization from hot alcohol well-marked little rhombic crystals. Melting-point 88° (uncorr.). It is almost insoluble in water and ether, freely soluble in hot alcohol, less so in cold. Its solutions decompose very easily, so that the greater part of the substance disappears on recrystallization.

Chloride of Benzyl Selenide.—An alcoholic solution of the nitrate gave with hydrochloric acid a white precipitate which yielded yellow or brown needles on recrystallization from alcohol. It consists of branching needles either yellow or brown; the color, however, is probably due to partial decomposition, as it is extremely unstable, being decomposed even below the boiling point of alcohol into selenium and benzyl chloride. It is slightly soluble in hot alcohol, and its solution is even more unstable than that of the nitrate.

An alcoholic solution of nitrate of benzyl monoselenide treated with hydrobromic acid gave selenium, and vapors which attacked the eyes violently, and were probably benzyl bromide $C_6H_5CH_2Br$. It seems, therefore, that the chloride and bromide of benzylselenide are decomposed according to the following reaction:

$$(C_7H_7)_2SeBr_2=2C_7H_7Br+Se,$$

while the bromide and iodide of methylselenide undergo an entirely different decomposition:

$$(CH_3)_2SeBr_2=(CH_3)_2Se+Br_2.$$

It is interesting that the replacement of one atom of hydrogen

in methyl by phenyl (which converts it into benzyl, HCH_3 into $C_6H_5CH_2$), should produce such a complete change in its attractions.

The nitrate of benzylselenide gave with potassic iodide a very unstable yellow precipitate.

Benzyl Selenide Platinic Chloride $[(C_7H_7)Se_2]_2PtCl_4$ was prepared by mixing alcoholic benzylmonochloride with aqueous platinic chloride. I could not obtain it crystallized, as its solutions decompose on evaporation. It was therefore purified by washing with alcohol

	Calculated for $[(C_7H_7)_2Se]_2PtCl_4$.	Observed.
Platinum	22·97	22·32

It is a yellow powder insoluble in water, slightly soluble in alcohol; on heating it turned black and gave off a combustible gas.

Benzyl Diselenide $(C_7H_7)_2Se_2$, was prepared by treating a sodic selenide (from the reduction of Na_2SeO_3 with charcoal) with benzyl chloride, this being the method by which Wöhler and Dean obtained their so-called methyl monoselenide; but, as I expected from Rathke's researches in the ethyl series, I obtained principally diselenide with only a base of monoselenide. The crude sodic selenide was boiled in a flask, with a return-cooler with alcohol and benzyl chloride; the liquid thus obtained deposited light yellow scales which were purified by crystallization from boiling alcohol.

	Calculated for $(C_7H_7)_2Se_2$	Observed.
Carbon	49·70	48·75
Hydrogen	4.14	4·48

It forms straw-yellow scales which are superficially decomposed by direct sunlight, burning brilliant red. It has very little odor, melts at 90° (uncorr.), and remains fluid a long time after it has been melted, burns with a blue selenium flame, and is insoluble in water, freely soluble in hot alcohol, less so in cold, soluble in ether, reacted on by hydrochloric acid, but oxidized by nitric acid.

Benzylselenious Acid $(C_7H_7)SeOOH$.—When benzyl diselenide was treated with strong nitric acid it dissolved with evolution of nitrous fumes to a colorless liquid, which on cooling crystallized in white needles. These were purified by recrystallization from alcohol or hot water.

	Calculated for $(C_7H_7)SeOOH$	Observed.
Carbon	41·58	41·61
Hydrogen	3·96	4·25

It occurs in radiated groups of white needles with a weak odor when pure; when slightly impure it smells like the

Mephitis americana. Melting-point 85° (uncorr.). But slightly soluble in cold water, indefinitely so in hot, quite freely soluble in cold alcohol, much more in hot, almost insoluble in ether. Its solutions have an acid reaction and set free carbonic anhydride from the carbonates.

Ammonic Benzylselenite was prepared by dissolving the acid in ammonia and driving off the excess of ammonia by evaporation on the water-bath. It is extremely soluble in water and can be obtained with some difficulty in wart-like aggregations of crystals.

Argentic Benzylselenite $(C_7H_7)SeOOAg$ was prepared by mixing aqueous solutions of ammonic benzylselenite and argentic nitrate. The white curdy precipitate was purified by crystallization from a very large quantity of boiling water.

	Calculated for $(C_7H_7)SeOOAg$	Observed.
Silver	34·95	34·33

It forms long hair-like crystals which mat together into a felt-like mass. When heated in the water-bath it turns black, but is not altered in direct sunlight. Slightly soluble in a large quantity of boiling water. Freely soluble in nitric acid.

Sodic Benzylselenite, prepared by neutralizing the aqueous solution of the acid with sodic carbonate can be obtained on evaporation as an imperfectly crystalline white mass very soluble in water.

Baric Benzylselenite, prepared by dissolving baric carbonate in an aqueous solution of the acid is white and very soluble.

Plumbic Benzylselenite, prepared by precipitating ammonic benzylselenite with plumbic nitrate is white and imperfectly crystalline, insoluble in cold water, and even less soluble in boiling water than the silver salt.

Benzyl Selenocyanate $(C_7H_7)SeCN$.—Alcoholic potassic selenocyanate, prepared according to the method of Crookes* was treated with benzyl chloride till its smell remained after shaking. The liquid poured off from the potassic chloride formed, deposited white needles which were purified by recrystallization from alcohol or ether.

	Calculated for $(C_7H_7)SeCN$.	Observed.	
Carbon	94·23	48·99	....
Hydrogen	3·59	3·92	....
Nitrogen	7·23	....	7·39

It crystallizes with the utmost ease in long white needles or prisms, with a most disagreeable smell like that of the *Symplocarpus fœtidus.* Melting-point 71°5 (uncorr.). It is insoluble in water, soluble in ether and alcohol unattacked by hydrochloric acid, oxidized by fuming nitric acid.

* Annalen der Chemie und Phamacie, lxxviii, p. 177.

Nitrobenzyl Selenocyanate, $C_7H_6(NO_2)SeCN$, can be prepared by nitrizing benzyl-selenocyanate with fuming nitric acid at $-4°$; on dilution, white crystals mixed with an oil are deposited; these were purified by pressing between filter paper and crystallizing from boiling alcohol. If nitric acid much above $0°$ was used, the amount of product was much smaller, and was mixed with an acid of the formula $C_6H_4(NO_2)COOH$, probably a mixture of nitrodracylic acid and one of the other isomeres. A more convenient way of preparing the substance consists in treating potassic selenocyanate with nitrobenzyl chloride, $C_6H_4(NO_2)CH_2Cl$, prepared according to Strakosch's method,* decolorizing with bone-black, and recrystallizing from boiling alcohol. The substances prepared by these two methods seem to be identical and not isomeric, as has been already observed in the case of nitrobenzyl sulphocyanate by Henry.†

	Calculated for $C_7H_6(NO_2)SeCN$.	Observed.
Carbon	40·00	40·87
Hydrogen	2·50	8·12

It forms globular masses of radiating needles resembling wavellite, has but little odor, melts at 122°·5 (uncorr.), is insoluble in cold water and alcohol, but soluble in both when boiling, insoluble in ether. It dissolves in ammonia, but is obtained unaltered from this solution by acidifying, or by evaporating to dryness and recrystallizing. It is possible that the substance prepared from benzylselenocyanate is a little more easily soluble in ammonia than that prepared from nitrobenzyl-chloride.

SELENINES.

These compounds correspond to the sulphines discovered by Oefele. They should be called selenoniums and sulphoniums instead of selenines and sulphines, as they correspond to the salts of the compound ammoniums, and not to the tertiary amines, as is evident from the annexed comparison:

H_3N	H^2S	H_2Se
$(CH_3)_3N$	$(CH_3)_2S$	$(CH_3)_2Se$
$(CH_3)_4NI$	$(CH_3)_3SI$	$(CH_3)_3SeI$

Further, they resemble the compound ammoniums in all their properties, especially in their tending to form iodine addition-products and alkaline hydrates.

Benzyl diselenide was moistened with an excess of methyl iodide and allowed to stand for several days; it turned black and became pasty. On washing the mass with water and evaporating the wash water, white prisms were obtained consisting of trimethylselenonium iodide $(CH_3)_3SeI$, already described by Cahours,‡ while the black residue consists of benzyl-dimethylselenonium-triiodide and benzyl iodide.

* *Berichte deutschen chemischen Gesellschaft*, vi, 1056. † Ibid., ii, 637.
‡ *Ann. Chem. Pharm.*, cxxxv, 352.

$$(C_7H_7)_2Se_2+5CH_3I=(CH_3)_3SeI+(C_7H_7)(CH_3)_2SeI_3+C_7H_7I$$

The presence of C_7H_7I was proved by obtaining tribenzylamine, $(C_7H_7)_3N$, by heating with alcoholic ammonia. The white crystals were converted into the chloride by treatment with argentic chloride, and from this the platinum salt was made and analyzed.

	Calculated for $[(CH_3)_3SeCl]_2PtCl_4$.	Observed.	
Platinum	30·07	29·27	....
Carbon	10·96	....	11·42
Hydrogen	2·74	....	2·79

Benzyldimethylselenonium Triiodide $(C_7H_7)(CH_3)_2SeI_3$.—The black residue already mentioned was washed very thoroughly with alcohol to free it from benzyl iodide and then recrystallized from boiling alcohol.

	Calculated for $(C_7H_7)(CH_3)_2SeI_3$.	Observed.		
Carbon	18·62	19·34	18·92	....
Hydrogen	2·24	2·66	2·87	....
Iodine	65·69	65·69	....	65·17

It forms very heavy black needles, with a metallic luster like that of iodine, and a most offensive odor. It melts at 65°, but softens a few degrees below its melting-point. Heated somewhat more it gives off vapors which attack the eyes violently, is insoluble in water, slightly soluble in cold alcohol, quite so in hot, slightly in ether. Its solutions are red, and are decolorized by gentle heating with metallic mercury. Rathke observed a similar action with a black oil which he obtained by acting on triethylselenonium iodide with iodine. This was undoubtedly the triiodide, but he gives no analysis of it. I have also obtained a black oil by treating trimethylselenonium iodide [redacted]

ART. XXI.—*Description of the Nash County Meteorite, which fell in May*, 1874: by J. LAWRENCE SMITH, of Louisville, Kentucky.

THE meteorite of Nash County, North Carolina, fell May 14th, 1874, at 2½ o'clock P. M., near Castalia, in lat. 36° 11′, long. 77° 50′. Its fall was accompanied with the successive explosions common in such cases, and with rumbling noises that lasted about four minutes, not unlike the discharge of firearms in a battle a few miles off.

The stones that fell must have exceeded a dozen or more; three only have been found, and they give evidence that the territory over which the fragments fell was ten miles long by over three miles wide. Although occurring in the day, the body appeared luminous to some observers. The three stones found weighed respectively one kilogram, 800 grams, and 5½ kilograms. The second was the fragment of one broken by the fall. Several fragments have come under my observation, from which I am enabled to give the following description.

They are of the more common aspect. They have a dull exterior coating, which in some places does not entirely cover the stones, there being a few spots of the fractured surface, less than a centimeter in diameter, over which the fused matter forming the coating is scattered in the form of pear-shaped beads. In one or two crevices, below the surface, some of the fused matter of the coating has penetrated five millimeters below the surface, and here it is more brilliant than on the surface.

The interior in many parts is of a dark gray color, and in other parts quite light; the principal cause of the dark color is doubtless owing to the larger amount of nickeliferous iron in that part, and in the lighter portion there are some white spots of a mineral that is doubtless enstatite.

The specific gravity of the stone is =2·601. Its composition is

Nickeliferous iron	15·21 p. c.
Stony minerals............	84·79

The nickeliferous iron consists of—

Iron	92·12
Nickel	6·20
Cobalt	·41
	98·73

Copper and phosphorus not estimated.

The stony part, when treated with a mixture of chlorhydric and nitric acid, gave—insoluble part, 47·02; soluble part, 52·98. The former was found to be composed as follows:

Silica	52·61
Alumina	4·80
Protoxide of iron	13·21
Magnesia	27·31
Alkalies (soda with traces potash and lithia)	1·38
	99·31

and is essentially bronzite. The soluble portion gave—

Silica	38·01
Protoxide of iron	17·51
Magnesia	41·27
Alumina	·46
Sulphur	1·01
	98·26

This is evidently olivine, with a small amount of sulphide of iron, which is so disseminated through the stone that it is not easily separated completely by mechanical means. From the mineralogical examination and the chemical results detailed above, this meteoric stone consists essentially of nickeliferous iron, bronzite and olivine, with small particles of anorthite and enstatite. Its composition is, therefore, a usual one.

For particulars in regard to the fall of this meteorite I am indebted to Prof. Kerr, State Geologist of North Carolina.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *Commercial Quinidine Sulphate.*—By this name various mixtures are known in commerce, such as of quinine and chinchonine sulphate, and of quinidine, cinchonine, and cinchonidine sulphates, beside the pure salt itself. Hesse recommends the following method for the examination of such mixtures: (1) One gram of the sulphate is dissolved in seven c. c. of a mixture of two volumes chloroform and one of 97 per cent alcohol. The pure salt dissolves, leaving behind any inorganic salts present. (2) Half a gram of the sulphate is digested at 60° C. with 20 c. c. of water, and 1·5 grams Rochelle salt is added, producing a crystalline precipitate. After standing an hour, the precipitate is filtered off; the filtrate should not show the slightest turbidity on adding a drop of ammonia. The production of a precipitate indicates the presence of cinchonine or quinidine. These may be distinguished by repeating the test with the addition of potassium iodide, as already detailed above. Or the cinchonine may be directly tested for by adding half a gram potassium iodide to the Rochelle salt solution; after an hour, the whole is filtered and a drop of ammonia is added. No precipitate is produced if cinchonine be absent.—*Liebig's Annalen*, clxxvi, 325, May, 1875. G. F. B.

On Chrysezarin, the Dioxyquinone of Chrysene.—In the se of an examination of certain specimens of commercial rin, CLAUS noticed in one of these a special substance, the solu- of which in potassa gave a blood-red color, instead of the vio- int of potassium alizarate. It is separated from the alizarin extracting the dry potassium salt with boiling alcohol. A brown residue is left on evaporation, which dissolves in water a yellow-red color, acids throwing down a lemon-yellow pre- ate. Crystallized from acetic acid, it forms dark brown nee- with a bronze reflection. It melts above 300° and sublimes 5°–310°, condensing again in brilliant orange needles. Anal- gives as its formula $C_{18}H_{10}O_4$, and that of its potassium salt $K_2H_8)O_4$. The author, hence, considers it the dioxyquinone rysene, and gives it the name chrysezarin. One kilogram of rin paste contains four or five grams of chrysezarin.—*Moni- Scientifique*, III, v, 396, May, 1875. G. F. B.

Production of Albumin from Fibrin.—GAUTIER shows that ialysing a solution of fresh blood fibrin in sodium chloride, norganic matters are separated, and there remains a liquid co- ated by heat, by mineral acids and by mercuric chloride, the ipitates having the composition of those from pure albumin.— *ptes Rendus*, lxxix, 227. G. F. B.

On the conversion of Brucine into Strychnine.—The close iical relation between the different alkaloids of the same t-species is a well observed fact. The two bases of the *Strych-* amily, strychnine, $C_{21}H_{22}N_2O_2$, and brucine, $C_{23}H_{26}N_2O_4$, no exception to this rule, and SONNENSCHEIN has recently eeded in showing that the former may be produced from the r at will. For this purpose the brucine is gently warmed four or five times its weight of dilute nitric acid. The liquid mes red and evolves carbonic acid. It is treated with potas- hydrate in excess, and agitated with ether. This on evapo- n leaves a red mass, from which, on solution and recrystalli- n, a crystallized bitter substance was obtained, having all the erties of strychnine. This result is of the greatest practical rtance. A student in the author's laboratory having been n a mixture containing lead nitrate and brucine, used the Otto method for detecting alkaloids, and found a substance ng the reactions of strychnine. Hence the use of nitric acid xamining for alkaloid poisons is to be avoided, since strych- may be thus formed.—*Ber. Berl. Chem. Ges.*, viii, 212, ch, 1875. G. F. B.

Formation of Indol from Egg-albumin. — NENCKI, in an er paper, having ascertained the fact that indol injected into body produces indigo-blue in the urine, made experiments to rtain if indol was a normal product of pancreatic digestion, as been asserted; and though the results were suggestive, they not final. Kühne having given it as his opinion that the thus obtained was not really indol, but some other body ly resembling it, Nencki returns to the charge and produces

indol actually obtained from albumin in this way, remarking that it may be much more readily prepared from this substance than from indigo-blue. For this purpose 300 grams commercial albumin was mixed with 4½ liters spring water, and an ox-pancreas, carefully freed from blood and fat, and finely divided, was added. The beaker, covered with a glass plate, was kept at 40°–50° for sixty or seventy hours. The liquid was then cooled, strained through cloth, acidulated with acetic acid to retain the excess of albumin in solution, and distilled on a water bath to one-fourth of its volume. The filtered and acid distillate was rendered alkaline with dry slacked lime and extracted with an equal volume of ether; the ether, on distillation, left having the characteristic odor of indol. Mixed with water it became crystalline, and recrystallized from water, it fused at 52°. Elementary analysis confirmed it as indol. The amount obtained was about 0·3 per cent of the albumin employed.—*Ber. Berl. Chem. Ges.*, vii, 1593; viii, 206, 336, March, 1875. G. F. B.

6. *Collodion Films.*—M. E. GRIPON states that if collodion is poured on a very clean plate of glass, the film may be separated when dry and stretched on a frame. Its surface is polished, and it reflects light like glass; it polarizes by reflection and by refraction, the angle of maximum polarization being 56° 25′, corresponding to an index of refraction of 1·5108, or a little less than crown glass. From this index we can, by observing the interference fringes, calculate the thickness, with a result varying from ·0081 to ·0088 mms. So thin a film cuts off but little radiant heat. With the flame of a lamp as a source, 91 is transmitted. With a blackened vessel containing boiling water ·70, with water at 50° but ·50, a proportion but little altered when the water is cooled to 20°. With two films the transmitted heat is ·583, the first one transmitting ·70, the second ·83.

A series of these films may be used to polarize light and heat by refraction; yet they are liable to break by the increase of tension when exposed directly to sunlight. Their diathermancy is much greater than that of piles of mica, and though more fragile, they are easily repaired. Two sets, each consisting of six collodion films, transmitted when crossed only ·66 as much heat as when placed parallel. A pile of nine films being placed before a Nicol's prism was found to polarize ·6 to ·7 of the heat.—*Comptes Rendus*, lxxx, 882. E. C. P.

7. *Combustion of Explosive Mixtures.*—M. NEYRENEUF has described two methods of showing the vibratory motion attending the explosion of a mixture of oxygen and hydrogen in a cylindrical tube. First, by using tubes carefully dried, and secondly by covering the interior with paraffine. In the first case the steam condensing on the colder portions leaves transparent the parts which the flame in vibrating has more strongly heated. These latter portions are, on the other hand, shown in the second case by the melting of the paraffine. It is indispensable that the combustion shall not be too rapid; and further, to obtain the best effects

the proportions of the mixture should be varied with the dimensions of the tube. With a tube 3 cms. in diameter and 20 cms. long, containing one part of hydrogen and one of air, lines appear, resembling fern-leaves. With tubes of less diameter the effects are more regular, especially if a musical sound is produced by the explosion. Fine striæ are then observed perpendicular to the axis of the tube. When the tube is very long, there is only a confused sound, but the striæ are well separated and sharply defined. If the mixture is ignited by the eudiometric method, these appearances are no longer produced. If the tubes are open at both ends, the effect is the same as if one end is closed. With a long tube the appearance in the dark is the same as that of a Geissler tube illuminated by a single motion of the breakpiece.—*Journal de Physique*, iv, 138. E. C. P.

8. *Changes in Light due to the motion of the luminous source or of the Observer.*—M. MASCART has examined this question both experimentally and theoretically. Arago announced that the refraction of the light of two stars, toward one of which the earth is approaching and from the other receding, was the same, and Fresnel showed that this could be accounted for if part of the ether was transported with the refracting medium, the change in refraction in fact being compensated by the motion of the telescope. Many efforts have been made to show optically the motion of the earth. Babinet thought he found a solution in the diffraction of gratings, and showed that in this case the compensation does not take place. This experiment, repeated under the most favorable conditions, both with solar and with artificial light, yields results wholly negative. And the delicacy of the method is such that the change, if any, must be very small compared with that given by Babinet's formula. Examining the theory further reveals a source of error in the assumption that solar light reflected from a mirror acts exactly as if it came from a source on the prolongation of the ray. But this is not correct if the mirror moves, as is the case on the earth, but the conditions are the same as if the mirror was itself luminous, or as if a terrestrial source of light was employed. Accordingly, as experiment shows, negative results only are obtained.

Suppose that we have two sources of light, one the soda flame, the second a star containing soda, and that both emit rays in the opposite direction from the motion of the earth. The absolute time of vibration of the two sources are identical, but the wave-lengths of the light emitted are different, owing to the motion of the first. The deviations of the two rays ought, therefore, to be different. To test this experimentally, two large instruments were constructed, one fixed with the collimator turned to the west, and inclosed in a cave where the daily changes of temperature were extremely small. The other was placed on a movable plate so that it could be pointed either east or west. Observations showed that the deviation was wholly inappreciable, although a displacement of a twentieth of that given by Fresnel's formula would have

been perceptible. But this formula contains two terms, of which the first is proportional to the velocity of the medium, but is very small, and slight changes in it are quite inappreciable. The principal term, on the other hand, seems to depend only on the apparent period of the incident light, and is therefore independent of the motion. By applying a modification of the method of the interference of plates it appears that there is not a difference of ·000005, or of ·000002, using the method of Newton's rings. The negative results of M. Hock on the interference of light passing through a refracting medium with or against the motion of the earth is similarly explained. Again, by the double refraction of Iceland spar, fringes were obtained differing by 50,000 or even 100,000 wave lengths, without a variation of ·000001 in their apparent position. With the rotary polarization of quartz with an instrument capable of detecting a change of plane of quarter of a degree and a rotation of fifteen circumferences, not the least change was preceptible, due to the motion of the earth.—*Jour. de Phys.*, iv, 129. E. C. P.

9. *New source of Magnetism.*—M. Donato Tommasi states that when a current of steam under a pressure of five or six atmospheres is passed through a tube of copper two or three millimeters in diameter, and rolled in a helix around a cylinder of iron, the latter is so strongly magnetized that an iron needle placed some centimeters from the *steam-magnet* is strongly attracted and remains magnetized as long as the steam passes through the tube.—*Comptes Rendus*, lxxx, 1007. E. C. P.

II. Geology and Natural History.

1. *The Geology of New Mexico.*—Prof. Cope stated that the ground covered by the geological investigation conducted mainly in New Mexico during 1874 in connection with the Wheeler U. S. topographical and geological survey, embraced the eastern slope of the Rocky Mountains from Pueblo to the Sangre de Christo Pass; both sides of the Rio Grande Valley from that point to Algodones, N. M.; the western or Sierra Madre range; and the country for forty miles to the westward of it, from the latitude of Sierra Amarilla as far south as the road from Santa Fé to Fort Wingate.

Little of novelty has been added from the first two named regions, as they have been previously traversed by competent geologists; but the last named has remained up to the present time almost unknown. The analysis of the structure of the Sierra Madre range is believed to indicate that its elevation took place near the close of the period known as Cretaceous No. 4, and that the elevating force was, in New Mexico, more powerful at its southern extremity than along the middle portions of its line. Another important discovery is the lacustrine character of the Triassic beds which form a part of the axis of the range; indicating the existence of extensive areas of dry land at that period, of

ich no portion is remaining in the region examined by him, but ich may be supposed to be represented by the palæozoic beds ther south and west. A third important point is the determinon that the plateau drained by the eastern tributaries of the n Juan River is composed of the sediment of an extensive lake Eocene age, which was probably at one time of great extent, t whose deposits have been greatly reduced in extent through sion. The boundaries of this lake to the east and south were ermined.

It is believed that additional light has been thrown on the quesn of the age of the Galisteo sandstone; and that its paleontoly has decided definitely that of the Sante Fé marls. The first sils discovered in the "Trias" of the Rocky Mountains, have abled me to reach more definite conclusions as to its position the scale of periods. The remains of vertebrata obtained from latter formation are those of fishes and reptiles. The former rhomboganoid scales of small species which are numerous in coprolites of the reptiles; the latter represent the three orders *Crocodiles*, *Dinosauria*, and apparently of *Sauropterygia.* e dinosaurian order is represented by a part of the crown of a th of a species of large size, of the general character of *Laelaps.* Prof. Cope describes the suspected Sauropterygian from a single rtebra, and names it *Typothorax coccinarum.* The flat and gularly fitted dermal bones distinguish this genus from *Belodon.* remarks that the evidence from this species is favorable to the ntification of this horizon with that of the Trias, although it nnot of course be regarded as conclusive, until more perfect ecimens are obtained.

The thickness of the Eocene of the region is estimated at 3,000 t, of the Cretaceous at about 5,000 feet, the Jurassic at 600 feet d the Trias at 1,000 feet or more.

2. *Fossil Ungulates from New Mexico.*—Professor COPE roc. Philad. Acad. Sci., 1875) has described a species of camel, out as large as the dromedary, from near Pojuaque, under the me *Pliauchenia vulcanorum.* The dental formula is, molars 3; also the *Hippotherium calamarium* Cope, from near San efonso, and *Aphelops Jemezanus* Cope, a rhinoceros, from near town of Santa Clara.

3. *Coal beds in the Subcarboniferous of Pennsylvania.*—Letter J. P. LESLEY, Director of the Geological Survey of Pennsylnia to J. D. Dana, dated June 26.—I have just learned the imrtant fact that Mr. Ashburner of this survey has discovered a nsiderable number of what he calls "baby coal beds" in No. X, pper or White Catskill, Rogers' Vespertine. They are exposed the tunnel of the East Broad Top Railroad through Sideling ll in Huntington County. Mr. Billin and Mr. Ashburner are connecting a section of all the measures from the Trenton up to the il of Broad Top, across the outcrops of the Clinton fossil orels, the brown hematites of the Hamilton, and the ores of IX d XI, Catskill and Umbral (or Cuyahoga of Newberry), with

heavy beds of Chemung fossils, close under the Catskill, and coal-beds in X, (Berea Grit of Newberry). This last discovery is of the greatest importance to American geology. It explains the presence of the two coal beds on the face of the Alleghany Mountains, and the fourteen small coal beds which I counted years ago behind (west of) the Peak Mountain in Wythe County, Southern Virginia.

4. *On the Devonian Trilobites and Mollusks of Ererê, Province of Pará, Brazil;* by Prof. C. F. HARTT and R. RATHBUN. 28 pp. 8vo. From the Ann. Lyc. Nat. Hist. N. Y., vol. xi, May, 1875.—The collections here described were made in the course of the Morgan Expeditions, 1870–'71. The paper contains descriptions of two new species of trilobites, *Dalmania Paituna* and *Homalonotus Oiara*, six of Gasteropods, of the genera *Pleurotomaria, Holopea, Platyceras* and *Bellerophon*, eight of Lamellibranchs, and one Tentaculite. The Brachiopods are described by Mr. Rathbun in an earlier paper (see this Journal, vol. vii, p. 607).

5. *Practical Guide to the Determination of Minerals by the Blowpipe;* by Dr. C. W. C. FUCHS, Prof. Univ. Heidelberg. Translated and edited by T. W. DANBY, M.A., F.G.S., Fellow of Downing College, Cambridge, etc. 88 pp. 8vo. London, 1875. (London, Field and Tuer; Philadelphia, Claxton, Remsen & Haffelfinger).—Dr. Fuchs's work on the Determination of Minerals, which is well known abroad, commences with a brief account of blowpipe reagents and reactions. A "General table" contains a synopsis of the subdivisions of mineral species based on blowpipe characters arranged for convenient use; and following this table, the characters of the species in these several subdivisions are mentioned in detail. A large proportion of the mineral species are included in this part of the work. The volume closes with an alphabetical table of the mineral species, giving for each the hardness, specific gravity, and crystallographic system.

6. *Mineralogisches Lexicon für das Königreich Sachsen*, von AUGUST FRENZEL. 380 pp. 12mo. Leipzig, 1874. (W. Engelmann.)—This work is an excellent treatise on Saxon Mineralogy. The descriptions are drawn up with accuracy and precision, and end with a full list of Saxon localities. Probably no region so small embraces within its bounds a larger number of mineral species—about 300.

7. *Commelynaceæ et Cyrtandraceæ Bengalenses*; by C. B. CLARKE, late acting Superintendent of the Calcutta Botanic Garden. Calcutta: Thacher, Spink & Co. 1874, folio.—This is an imperial folio volume, of 135 printed pages and 93 lithographic plates, illustrating the Bengalese species of the two orders abovementioned. Of the *Commelynaceæ* Mr. Clarke had made a previous study, and published a good paper in the Linnean Society's Journal, in 1870, a little before Dr. Husskarl's elaborate *Commelynaceæ Indicæ* appeared. Mr. Clarke recognizes much fewer genera than the Dutch botanist, and probably takes a sounder view of generic limitation. The outline figures now given, so far as orig-

inal, are from drawings by native artists, who were ignorant of botany. They are neat and clear, and evidently give the facies with accuracy. The dissections, which are not very many, are from the author's own sketches, and are doubtless "tolerably correct," although he is "totally uninstructed in drawing." That so sumptuous a work of the kind can be published in Calcutta argues well for the interest there taken in the indigenous botany, and the price (ten rupees) is most moderate. If the work were to be continued, a smaller form, like that of Wight's Icones would be more convenient and more practicable. A. G.

8. *The Box-Huckleberry* (*Gaylussacia brachycera* Gray) is one of the rarest of North American plants. The elder Michaux's habitat is in Virginia, near Winchester, but the specimen in his herbarium at the *Jardin des Plantes*, is ticketed "Warm Springs." Pursh's is "Western parts of Virginia, near Winchester and the Sweet Springs"; and, if I rightly remember, some specimen of his collecting was ticketed "Cacapon Mountains." Muhlenberg's specimen, from Matthew Kin, is ticketed "*Krien Preyer*": Anglice Green-brier. All this relates to the Alleghany Mountain region, west of the Blue Ridge. I am not aware that any of these stations have been rediscovered, or that any living botanist has seen this little evergreen shrub in Virginia. The only available habitat known in our time, is the one which Prof. Baird discovered, fully thirty years ago, in Perry County, near Bloomfield, Pennsylvania; also in the Alleghany region, but more northward. From this station the Botanic Garden of Harvard University fortunately still possesses one or two thriving living plants The locality was restricted, and, Prof. Baird informs me, is now probably extinct through the bringing of the ground into cultivation. It is pleasant to be able to announce that Mr. A. Commons, of Wilmington, has just discovered a new locality, but in a wholly unexpected district, namely, in Susex Co., in the southern part of Delaware. He found it "while walking along the banks of Indian River, on the edge of a pine forest which here skirts the shore, growing under the shade of the Laurel (*Kalmia latifolia*) on a dry sandy bank" The plants were very sparingly in fruit. We hope that this diminutive shrub will now become more familiar to botanists, and that it may be brought anew into cultivation. It resembles a dwarf Box. The flowers are rather pretty, but inconspicuous. A. G.

9. *On the preservation of Anatomical Preparations.** — Dr. Sesemann of St. Petersburg, gives an account in the last number of Reichert and DuBois Reymond's "Archiv fur Anatomie, Physiologie," etc., of his experience in the use of preserving solutions for anatomical preparations, which may be of some interest to zoologists, as well as anatomists.

* Abstract of an article entitled "Ein Beitrag zur Conservirung anatomischen Präparate," von Dr. E. Sesemann in St. Petersburg.
Archiv. f. Anat. Phys etc., Reichert u. Dubois Reymond. 1874. No. 6 (published April, 1875), p. 679.

The first solution mentioned is composed of 6 *parts carbolic acid*, and 100 *parts olive oil* (parts, "*theilen*," refers probably to measures by bulk and not by weight). This solution he injected into the main arteries of a human hand. After exposure to the air for a few weeks the preparation became completely shriveled. A second solution of 3 *parts carbolic acid* and 10 *parts glycerine*, was used in the same manner with a similar result.

Prof. Laskowsky's method is then given. The solution used by him, is composed as follows:

100 parts glycerine, pure ("*rohen*"), 2 of carbolic acid, and 2 of acetate of soda.

The part of the subject experimented upon is left to soak in this solution for five to twenty days, according to its size. When taken out the specimen is quite hard, but after hanging sometime in the open air, it becomes fresh ("*rein*") again and remains so a long time unchanged.

Dr. Sesemann tried this process with a prepared hand of a human subject. He left the specimen in the solution 6 days; upon taking it out, it was completely hard, but became softer after a few days' exposure to the air. The muscles, however, had become of a dull brown color, and grew darker with longer exposure. The "*Van Vetter*" process is next described. In the place of the last solution, the following was used:

7 parts glycerine (22), 1 part sugar, ½ part saltpetre.

This process was not found satisfactory, as the sugar crystallized out upon exposure and the muscles became brown, as in Prof. Laskowsky's process.

After various experiments, Dr. Sesemann hit upon the following method as in all respects the best.

Sesemann's method.—The blood is first pressed out of the larger vessels as completely as possible. Then solution (No. 1) is injected.

$$\text{Sol. No. 1.}\left\{\begin{array}{ll} 100 & \text{parts water.} \\ 50 & \text{" glycerine.} \\ 10 & \text{" arsenate of soda.} \end{array}\right.$$

(The *arsenate of soda* is prepared by adding arsenic to a hot concentrated solution of soda until no more of the former dissolves). The specimen is left then for 24 hours, when it is again injected with solution, No. 2.

No. 2.—Glycerine and water in equal parts.

After waiting another 24 hours, it is immersed in water heated to 70 or 88 degrees Cent. (about 160°–175° Fahr) and left there 10–12 minutes. When taken out, and while still warm the vessels may be injected with wax, if it be desired. This being done, the epidermis is rubbed off with a rough cloth. A dull knife may be used for this purpose, though liable to injure the skin. It is well to moisten the specimen occasionally. If wrapped in a cloth moistened with water, glycerine and carbolic acid the specimen will keep a long time, and the anatomical structures may be

ed and exposed at the student's leisure. After such prepara-
s completed the skin should be put back in its place and fas-
together with pins. It is then to be immersed in solution
, consisting of

parts pure glycerine, 20 of water, 4 of arsenate soda, and
2 of carbolic acid,

eft in this solution 5–30 days according to the size of the
nen. When taken out it is ready to expose to the air indefi-
. The skin may turn a little brown after some time in the
phere, but this may be remedied by covering it for a few
with a cloth which has been moistened with a concentrated
on of corrosive sublimate in water.
e author says further that though a rather long process, it is
mended by the beauty and durability of the preparation.
as specimens thus prepared, which after several months' ex-
e to the air, have the appearance of having been just cut
the subject. He also suggests that it is further recom-
ed by the smallness of expense involved.
ution No. 2, after becoming weak from repeated use, may be
ed and brought back to normal strength by putting in a tin
nd this in a large wash kettle and heating it for some time
a slow fire, then filtering the solution through a linen cloth.
filtration will also remove albuminous substances, which the
will tend to coagulate. H. S. W.

III. Astronomy.

Diameters of the Planets.—We give the following values of
pparent diameters of the planets reduced to the mean distance
e earth from the sun and of their true diameters in English
, as being perhaps as reliable as any that can be assigned
existing data. They are founded in every case upon the
ures which from observational circumstances appear to de-
the greatest weight, and in the reduction to true values the
parallax is taken 8″·875, and Clarke's diameter of the earth's
tor is adopted. It would of course be idle to attempt to offer
numbers, where the difficulties attending observations and
differences between the results of the most experienced and
rably-circumstanced observers are so considerable.

	″	Miles.	
Mercury	6·35	2,850	
Venus	16·95	7,550	
Mars	9·305	4,150	
Jupiter, Equat.	197·47	88,200	Compression $\frac{1}{15 \cdot 54}$
" Polar	184·76	82,500	
Saturn, Equat.	166·82	74,500	Compression $\frac{1}{9 \cdot 10}$
" Polar	148·50	66,300	
Uranus	68·57	30,600	
Neptune	67·26	30,050	

xing upon the apparent diameters of the bright planets it has
desired to adopt values which shall represent the actual arc

values that are presented by the true diameters at the earth's mean distance. Many observations would assign larger values, but undoubtedly less trustworthy for computing real dimensions. As is well known, preference in such case is to be given to double-image over wire-micrometer measures, yet even if we confine ourselves to the former mode of observation we by no means secure great consistency of results.—*Nature.*

2. *Small Planets recently discovered.*—Upon p. 474, vol. i, (III) of this Journal, was given a table of the elements of the small planets recently discovered. We continue that table below, down to No. 143. A few of the later planets of the previous table are repeated. The elements as far as No. 136 are from the *Berliner Astr. Jahrbuch* for 1877.

No.	Name.	Time of discovery.	Discoverer.	Mean dist.	Angle of Eccent. °	′	Incl. °	′	Long. of node °	′	Long. per. °	′
107	Camilla,	Nov. 17, 1868	Pogson.	3·5602	7	[illegible]	9	48	175	41	112	50
108	Hecuba,	Apr. 2, 1869.	Luther.	3·2113	5	46	4	24	352	17	173	49
109	Felicitas,	Oct. 9, "	Peters.	2·6950	17	28	8	3	4	56	56	1
110	Lydia,	Apr. 19, 1870.	Borelli	2·7257	3	51	5	58	57	19	329	18
111	Ate,	Aug. 14, "	Peters.	2·5927	6	3	4	57	306	13	108	43
112	Iphigenia.	Sept. 19, "	Peters.	2·4335	7	23	2	37	324	3	338	9
113	Amalthea.	Mar. 12, 1871.	Luther.	2·3767	5	2	5	2	123	12	198	58
114	Cassandra,	July 23, "	Peters.	2·6758	8	3	4	55	164	24	153	0
115	Thyra,	Aug. 6, "	Watson.	2·3793	11	11	11	35	309	5	43	1
116	Sirona.	Sept. 8, "	Peters.	2·7661	8	17	3	35	64	26	152	53
117	Lomia,	Sept 12, "	Borelli.	2·9907	1	19	14	58	349	39	48	46
118	Peitho,	Mar 15, 1872	Luther.	2·4355	9	26	7	49	47	13	77	4
119	Althaea,	Apr. 3, "	Watson.	2·5804	4	48	5	47	204	0	12	27
120	Lachesis,	Apr 10, "	Borelli.	3·1200	2	42	7	1	342	52	212	52
121	Hermione,	May 12, "	Watson.	3·4606	7	0	7	36	77	0	0	56
122	Gerda,	July 31, "	Peters.	3·2196	2	8	1	36	178	55	208	38
123	Brunhilda,	July 31, "	Peters.	2·6931	6	31	6	27	308	40	72	5
124	Alceste,	Aug. 23, "	Peters.	2·6297	4	30	2	56	188	26	245	42
125	Liberatrix,	Sept. 11, "	Pros. Henry.	3·0352	20	17	6	5	171	16	251	17
126	Velleda,	Nov. 5, "	Paul Henry	2·4399	6	6	2	56	23	7	347	46
127	Johanna,	Nov. 5, "	Pros. Henry.	3·3211	11	46	8	33	31	23	101	24
128	Nemesis,	Nov 25, "	Watson.	2·7500	7	13	6	15	76	45	12	21
129	Antigone,	Feb. 5, 1873.	Peters.	2·8758	11	57	12	11	138	1	240	57
130	Electra,	Feb. 17, "	Peters.	3·1298	11	46	22	56	146	8	20	16
131	Vala,	May 24, "	Peters.	2·4202	4	40	4	39	65	10	258	25
132	Aethra,	June 13, "	Watson.	2·6010	2	27	25	0	259	43	152	11
133	Cyrene,	Aug 16, "	Watson.	3·0648	7	51	7	14	321	16	248	0
134	Sophrosyne	Sept. 27, "	Luther.	2·5673	6	[illegible]	11	36	346	30	66	52
135	Hertha,	Feb. 18, 1874.	Peters	2·4315	11	45	2	18	343	59	318	45
136	Austria,	Mar 18, "	Palisa.	2·3035	6	30	9	41	186	9	307	12
137	Meliboea,	Apr. 21, "	Palisa.									
138	Tolosa,	May 19, "	Perrotin.	2·4297	8	29	3	16	54	56	310	35
139		Oct. 10, "	Watson.	2·8141	2	57	8	19	348	37	115	32
140	Polana,	Oct. 13, "	Palisa.	2·7069	11	25	3	10	107	15		
141	Lumen,	Jan. 13, 1875.	Paul Henry.		12	54	11	33	318	59		
142	Siwa,	Jan. 28, "	Palisa.									
143	Adria,	Feb. 23, "	Palisa.	2·7525	3	49	11	32	333	41		
144	Vibilia,	June 3, "	Peters.									
145	Adeona,	June 3, "	Peters.									
146	Lucina,	June 8, "	Borelli.									

H. A. N.

. *Diameter of the Sun.*—From a discussion of the Greenwich ervations, 1836–1870, Dr. Fuhg obtains, *Astron. Nach.*, 2040, 2″.99 as the diameter of the sun deduced from 6827 measure-its.

IV. Obituary.

ıR William Logan, the Geologist, died at London, in June, ıis 79th year, having been born in Montreal in April, 1798. Sir lliam Logan was head of the Geological Surveys of the Can-s from 1843 to 1871. After graduation at the University of nburgh, in 1818, he joined the mercantile house of his uncle in ıdon, and later became manager, for the house, of coal mining . copper smelting operations in Swansea, where he studied so urately the coal field of that region, that his maps and plans it were later adopted by the Ordnance Geological Survey of at Britain. In 1841 he visited the coal fields of Pennsylvania and ra Scotia, and communicated several valuable papers to the ılogical Society of London. The Geological Survey of the ıadian Provinces had its origin in his researches. He was re-kable for extreme care in investigation, and great caution in wing conclusions—qualities which appear everywhere in his ılogical Reports; and his labors have contributed vastly to knowledge of North American Geology. He became a mem-of the Royal Society of London, and of many other learned eties. The Wollaston medal of the Geological Society was rded to Mr. Logan in 1856, and he was knighted by Queen toria in the same year.

oseph Winlock was born Feb. 6, 1826, in Shelby County, ıtucky. Graduating, in 1845, at Shelby College, he afterward l the professorship of Mathematics and Astronomy in that in-ıtion until 1852. The remainder of his life was passed chiefly 'ambridge, Mass.; but he spent some months at the U. S. Naval ervatory in Washington, and for more than a year was at the 1 of the mathematical department of the U. S. Naval Academy Annapolis. He was twice made Superintendent of the Ameri-Ephemeris, finally quitting this office in 1866 to take the post 'hillips Professor of Astronomy at Harvard University, and in : capacity to serve as Director of the Observatory. He held office at the time of his death, June 11, 1875. His last illness short, and did not appear dangerous until a few hours before termination.

'rofessor Winlock was an excellent mathematician and astrono-, and had a remarkably retentive memory not only for facts ting to his branch of science, but for the sources of information cerning those facts. The originality of his mind, however, was ·fly shown in his suggestions for the improvement of astronom-instruments. These inventions were singularly simple and ctive. Four among them deserve special notice in this place. ..) The mounting of large meridian circles in such a manner as .llow the piers to be shortened, so that the graduated circles

are wholly above the piers, and the steadiness of the whole instrument is increased. The theoretical advantage of this arrangement cannot here be discussed; it has been tested by five years' experience at Harvard College Observatory with very gratifying results; it has been adopted in other observatories, and will probably come into general use.

(2.) The application of a diagonal eye-piece, moved by a rack and pinion, to any large telescope, in such a manner as to dispense with the customary "finder," and to enable the principal object glass to be used in finding faint objects which are to be examined with the spectroscope or otherwise. This invention has also been for some years in use at Harvard College Observatory.

(3.) A method of registering spectroscopic observations by marking lines upon a silver plate without requiring the removal of the eye from the spectroscope, or the use of artificial light. Professor Winlock registered in this manner his observations of the solar eclipse of December, 1870, which he observed in Spain.

(4.) The use of a lens of long focus and of a plane mirror in making photographs of the sun. Apparatus of this kind was brought into daily use in July, 1870, at Harvard College Observatory. Priority in this invention is claimed by some other astronomers; but it does not appear that any one actually used the combination of the mirror with the lens of long focus until some years after Professor Winlock. It should also be noticed that in 1869 Professor Winlock first photographed the solar corona without enlarging the image by an eye-piece.

During his connection with the Observatory, Professor Winlock greatly increased its instrumental equipment, and also its pecuniary resources, by the aid of contributions from neighboring friends of science. In particular, the system adopted for furnishing electric signals from one of the clocks at the Observatory to various points in Boston and elsewhere, has been profitable alike to the Observatory and to the public. It illustrates Professor Winlock's practical good sense, that instead of introducing new clocks, controlled by that at the Observatory, at the places where the signals are received, he provided simple telegraphic apparatus for the reception of the signals every two seconds; a method much cheaper than the other, and in practice equally satisfactory.

In private life, Professor Winlock's amiable, though reserved character greatly endeared him to his friends. A. S.

Prof. Heinrich d'Arrest, of the University of Copenhagen died on the 14th of June, in his fifty-third year.

The most important of the labors of this distinguished astronomer were the construction of two catalogues, the one of nebulæ observed by him at Leipzig, the other of nearly 2,000 nebulæ observed by him at Copenhagen. For these observations the Royal Astronomical Society of London awarded to him this year their gold medal.

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[THIRD SERIES.]

ART. XXII.—*On the formation of Hail in the Spray of the Yosemite Fall*; by WILLIAM H. BREWER.

[Substance of a paper read before the California Academy of Natural Science, April 19th, 1875.]

THE Yosemite Fall pours into the valley from the north. It is in an open niche or recess of so wide an angle that the whole sheet of the Upper Fall (in April) is in the full sunshine, from before 8 A. M. until after 2 P. M. The Upper Yosemite Fall is about 1,550 feet high. Below it, the stream descends, by a series of cascades and falls, about a thousand feet more to the bed of the valley.

On the 14th of last April, in company with Mr. Galen Clark, the official custodian of the Yosemite valley and well-known mountaineer, I visited the foot of this Upper Yosemite Fall and observed the phenomena to be described. During our visit of four days to the valley, the sky was nearly cloudless, each morning perfectly so, a few cumuli only appearing each day at about 10 A. M. and disappearing at or before sunset. The air was warm, the temperature rising to above 70° F. each day, and sinking at night to perhaps 50° or less. The streams were all very high from the melting snow, which was abundant on all the heights above the valley.

In the winter a great "ice-cone" forms at the foot of this fall, the accumulation of frozen spray. That formed last winter was much reduced in size by thawing at the time of our visit. I then thought it perhaps 100 feet thick. Messrs. Clark and

Conway, the two persons most familiar with it, gave their estimates, respectively, as "60 to 100 feet" and "nearer 200 feet." This ice-cone rises like a wall in front of the sheet, and then slopes from its apex down stream for some hundreds of feet. The water pours behind it, finds it way beneath and emerges from an ice arch below, strongly reminding one, both in shape and general appearance, of the ice-arch in the glacier at the source of the Arveiron at Mt. Blanc.

Later in the season, as the stream decreases in volume, it clings to the wall for some distance near the top, but at this time it left the rock at the very crest, shooting well out into the air, falling the whole immense distance in one grand leap. As a member of the State Geological Survey in former years I had visited the valley several times, always later in the season, and never before saw the volume of water half so large. From observations made by Professor Whitney at other seasons, it is probable that at this time the amount of water passing over the fall was 250 or 300 cubic feet per second. A heavy storm a week or so before had swollen the stream, and mud and sand had been carried out in the spray, tarnishing much of the surface of this ice which had before been pure white.

As we stood on the rocks near and above this ice—it was half an hour past noon—certain appearances suggested to me that the spray which drifted over it was, in part at least, snow. To reach the middle of the ice, without ropes to cling to, was impossible, for no man could withstand the fierce blast. We ventured, however, as far as we could go, and where, at times, it seemed as if we would be hurled into the chasm below.

Between the wall of granite behind and the wall of ice in front the stream fell with deafening sound. Great volumes of spray belched from the open throat of this abyss and swept furiously over the ice-cone toward the valley below. In this tempest, which stung our hands and faces like shot, we found abundant *hail* or ice-pellets. Their structure could not be studied in the blinding blast to which we were subjected, but like hail-stones, they were of hard ice, tolerably uniform in size, and I estimated their diameter at one-tenth of an inch. They accumulated on our clothes and on the windward side of rocks which came up through the ice-cone near its edge. They were found also (rapidly melting) on the rocks by the side of and near the ice. Farther down upon the cone many depressions in the dirty ice were filled with what looked like new white snow, but which we believed to be fresh accumulations of this hail; from their position it was impossible to reach and examine them.

We retreated from the ice and then pushed our way back to the granite wall over which the fall pours, and went as near the

›t as it was possible to stand or breathe. No fresh light on matter was here gained. Having no protection for the eyes our hats, nothing could be seen distinctly, and if any hail ırred there I could not feel it. At a little greater distance n the fall, and where from time to time by the swaying of the ›t we were left sufficiently outside the spray to look ›ard, the near views were indescribably grand. More than ıarter of a mile above us the clear stream leaped out into air and was soon torn into spray. It seemed as mobile as ›ke and assumed new varieties of outlines each instant, so t and airy that it seemed as easily swayed by wind as lace, it struck with deafening thunder; the concussion was per- ‹ible through the granite for some distance and it was only this that the vast forces involved were appreciated.

ılthough foreshortened from our position, by an illusion its ght appeared greatly and abnormally increased. The mass spray increases downward so that the base of the sheet is eral times wider and thicker than the top, forming a sort of ving truncated cone. The actual height is so vast and so ch beyond ordinary experience that it excites the imagina- ı and deceives the judgment, and when thus seen from be- in the intense illumination of the midday sun in that clear nate, looking up and along this white, airy, changeable cone, tapering from the observer seems due mostly to its distance, l by this false or imaginary perspective it seems to stretch vard toward the intensely blue sky to an immense but vague ght.

Ve had no thermometer with us to test temperatures at or ır the fall. At Leidig's hotel in the valley, which is one and ›-eighths miles distant in an air line and a thousand feet lower, thermometer showed the following temperatures for that ⁊. At 6 A. M., 52° F.; at 2.30 P. M., 78½°; at 3.15 P. M., '; at 9 P. M., 58°: and at 6 the next morning, 50°. These re probably about the temperatures of the other days of our it. I had no wet-bulb to determine the dryness of the air, t that the air was very dry was shown by the rapidity with ich our saturated clothes dried.

[t will be noticed that at the time when this hail was ob- ved, the sheet was in the full blaze of the sun from top to tom and the heat further reflected toward it by the naked lls of rock sloping toward it on either side, and that the air ır was of a temperature above 70°, perhaps, however, much ı near the top of the fall. We were fully convinced while re that the hail was then actually forming, and not that it ı merely portions of ice torn from the great ice-cone and ·led along with the spray by the blast.

Vhen I first visited this fall in June, 1863, we had intended

to have tested the temperature of the water at the top and the foot, to see if the entire fall of 2,550 feet sensibly heated the water. We became convinced that the rapid evaporation then taking place would vitiate any results obtained, so the experiment was not tried as it involved too much labor to be expended for so unsatisfactory a result. And on examining this hail, the cause of its formation, which immediately suggested itself, was evaporation.

The stream was then swollen by the melting snow which was still deep on the heights, and was abundant in niches to the very crest of the fall (which has an altitude of about 6,600 feet above the sea). The volume of water each day was least in the early morning and increased much during the day, thus showing its source. In the Fall it appears to be "atomized" for 1,200 or 1,400 feet of its descent. A great volume of air is drawn into this great falling mass along its whole course, the sheet spreading as it descends. The quantity of air is so great that it pours outward on the bottom of the valley and is very perceptible as a cool current more than a mile distant from the base of the upper Fall. The air as sucked into the Fall is immediately cooled to 32° by the ice-cold water. As it passes in, it is very dry, and the rapid saturation within the sheet is sufficient to freeze a portion of the drops.

Prof. John LeConte, of the University of California, who is familiar with the locality, has suggested that perhaps the cooled air within the sheet is somewhat compressed and condensed in the base of the fall, and when liberated just outside, by its expansion, freezes a part of the spray.

Art. XXIII.—*Walker's Statistical Atlas of the United States.* (Second paper.)

In a former notice of this excellent work we sketched its plan and scope, reserving for another article some further notice of its first part. This relates to the "Physical Features of the United States," and is the part to which students in the physical sciences naturally turn with most interest.

The first map relates to the "*River Systems*," and the first memoir to the "*Physical Features.*" The map was prepared by Gen. A. von Steinwehr, and the memoir by Prof. J. D. Whitney, these authors having worked independently of each other. About seven-eighths of Professor Whitney's sketch is devoted to the mountain frame-work or skeleton of the country, and that of the *River Systems* supplements this. One may be said to describe the anatomy of the country, the other its physiology. This map

is by far the best of its kind we have yet seen of the country. Twenty-one drainage areas are denoted (each accompanied with certain statistical information), the whole naturally thrown into groups or systems, only one of which we will here notice.

According to this map, the Mississippi basin embraces about 1,258,000 square miles of our domain. A small portion of the Missouri basin extends into British America, perhaps about 22,000 to 25,000 square miles. If this be added, the area of the whole basin will be about 1,270,000 to 1,273,000 square miles. This is somewhat larger than the area usually given by the authorities most often consulted. The figures from the Report upon the Physics and Hydraulics of the Mississippi River, by the U. S. Topographical Engineers some years ago, are 1,244,000 square miles, while the various works on geography and physical geography usually give it from 1,200,000 to 1,250,000. This "Great Central Valley," as a geographical feature of the continent, is, however, much larger, including on its southern borders portions which drain directly into the Gulf, and northward passing insensibly into the great areas which drain into Hudson's Bay and even into the Arctic Ocean.

The Mississippi basin, according to this map, contained at the last census, a population of about 16,292,000, exclusive of "Indians not taxed." The whole basin is divided into six parts,—the Lower Mississippi, Upper Mississippi, Ohio, Missouri, Arkansas and Red River basins. The basin of the Ohio has naturally the greatest population. Somewhat almond-shaped in outline, or like a leaf, veined with large rivers, its point reaching to New York, it was the natural channel down which emigration flowed westward to the greater valleys beyond. Its genial climate, fertile soil, its prairies here, and wealth of timber-land there, have so attracted the settler that it will probably long remain the most densely populated basin of the system. The "center of population" of the nation passed into it about forty years ago. Another century will probably find it still there. The area is given as 207,000 square miles (the Report on Hydraulics, &c., already cited, stating it as 214,000), or about one-sixth of the whole Mississippi basin, and its population, 7,800,000, is nearly half of the population of the whole basin.

The Basin of the "Upper Mississippi" is credited with an area of 179,600 (169,000 according to the other authority quoted) and a population of about 4,000,000. The Missouri basin has an area of about 528,000 square miles, and a population of about 1,524,000. If we add to this last area the estimate already given for that part outside the United States, it would give the entire Missouri basin an area of about 550,000 to 553,000 square miles. The Engineers' report previously cited estimates it at 518,000.

The estimated average annual rain-fall is given for each of the basins of the map. If now we continue our comparisons between the basin of Missouri and Ohio, we find 18 inches for the former and 43 for the latter The first is probably too high. Plate V is a "Rain Chart of the United States," prepared by Chas. A. Schott of the U. S. Coast Survey, under the direction of Professor Joseph Henry, from materials in possession of the Smithsonian Institution. On this map we find that much of the Missouri basin (indeed it appears to be much the larger part) is there accredited with 12 inches or less. But on the estimate of the first figures, if we computed the amount of water falling in each entire basin, we find them very nearly equal,—that in the Missouri basin to that in the Ohio basin as about 1·1 to 1. Considering the vastly greater area for evaporation in the former, 2·65 to 1, and the dryer atmosphere, we are rather surprised that the comparative excess of water discharged by the Ohio is not greater than it is. According to the report cited, the mean discharge of the Missouri River is 120,000 cubic feet per second, of the Ohio 158,000. On the rain-chart, much or most of the basin lies inside of the line of 12 inches annual rain-fall, and only the very small part that lies below Atchison, Kansas, has 32 or more inches. On the same chart the lowest rain-fall of the Ohio Valley is 36 inches, reaching 62 in its extreme southern part.

Plate VII, "Temperature Chart of the United States" (of the same authority as Plate V) shows that the mean annual temperature of the Missouri basin is about 10° F. less than that of the Ohio. The isothermal line of 48° F. at lon. 110° W. is in lat. 48°. It sweeps down near or a little above the center of the Missouri basin, crossing the river at Fort Randall, sinking to lat. 39° in southern Iowa (more than 600 miles south of our starting point), then it rises again eastward so as to keep entirely outside of the Ohio basin. Very nearly all the Ohio basin lies between the isothermals of 50° and 60°. The Missouri basin has a much wider range.

Even more suggestive is a comparison of these two basins with plate VIII, which is an "U. S. Signal Service Chart" showing the mean temperature at 4.35 P. M. of each day "of the hottest week of 1872" (by red lines), and of the 7.35 A. M. observations "of the coldest week" of the winter following (by blue lines). It will be seen that this chart does not show the actual range of temperature as indicated by the single extreme maximum and minimum observations of the year. It is rather a comparison of the coldest "spell" of the year with the hottest. On this, we find the greatest difference near the eastern base of the Rocky Mountains, or on the plains eastward. At Fort Benton this difference is upward of 102° Fahr. It di-

minishes eastward to the eastern base of the Apallachian system, amounting to 80° in northern New England, but south of New York it is usually less than 70°. The hot line of 85° in eastern Dakota is north of the cold line of −20, and passing eastward, successively cuts every cold line to +20, which it crosses in eastern Delaware. The hot line of 90°, which is first traced above Fort Benton, crosses the Ohio River near Cincinnati, and ultimately reaches the Atlantic near Cape Charles. The hot week was as hot in the Missouri basin as in that of the Ohio. During the cold week, nearly all the Ohio basin was between +5° and +20°, while in that of the Missouri the average was from zero to −20 and lower. Space forbids a further comparison of these two basins, or any notice of others we intended to have dwelt upon.

This last chart is of much interest to the student in biology. In Dakota (beyond which the lines are not traced) we have a difference of 105° F., and over large areas of the plains, a difference of 100° F. On the 91st meridian, the hot line of 90° is 330 miles north of the cold line of +10°; they cross each other near Cincinnati: and on the 83d meridian they are again 340 miles apart but in the reversed order. Again, the hot line of 85° and the line of +20° are together: in fact they cross in southeastern Delaware. They separate westward, the cold line crossing extreme southern Arkansas, the hot line running up to Dakota, more than 950 miles north. Again, in the longitude of Raleigh, N. C., the minimum line of +30° is but 130 or 135 miles from the maximum line of 90°. Passing westward, the former descends to lat. 27° in Texas, the latter rises to lat. 48° in Montana, equivalent to a distance of about 1450 miles on the meridian. These climatic peculiarities, taken in connection with the nature of the storms of winter and the sudden changes of temperature sometimes occurring there, must have much greater influence on the distribution of life than the annual means of temperature and rain-fall. It is, perhaps, practically there the controlling condition. That a dry and hot climate may have a flora and fauna rich in species is illustrated by South Africa. But this "middle region" is poor in species, and the whole of it is without forests as shown in the "Map of Woodlands."

The excellent geological map, compiled by Professors C. H. Hitchcock and W. P. Blake, we have already noticed. On it, the "Carboniferous and Permian" are shown as a single member. That portion lying east of the 100th meridian forms a broad doubly curved belt, like a huge inverted letter S, reaching from New York to Texas, with a few outlying patches, the largest of which is in Michigan. The upper division of the Carboniferous series, "the Coal Measures," is shown on a large

(double plate) "Map of the Coal Fields of the United States," by Prof. C. H. Hitchcock. We have heard several persons speak of this as the most impressive map of the series; it may perhaps be so to many who love to dwell upon the future resources of our nation. The map is accompanied by an explanatory memoir. The following are the areas given of the groups specially treated.

New England basin	750	sq. miles.
Anthracite basins of Pennsylvania	472	"
Appalachian Coal Field	59,105	"
Michigan basin	6,700	"
Illinois basin	47,188	"
Missouri basin	84,343	"
Texas Coal Field	6,000	"
	203,808	

In addition to this, there are a few small areas of Triassic coal, amounting to a few hundred square miles at most. The various important deposits of coal west of the 100th meridian are not noted. Indeed the data does not exist to satisfactorily show the areas which they cover.

When we consider the educational and statistical value of the Atlas under consideration, it is greatly to be regretted that a large edition was not ordered by Congress, to be sold at the lowest cost of manufacture. As it is, the lithographer, Mr. Bien, is allowed to issue an edition at his own risk, and this will allow all who wish the work to purchase it at a rate which under the circumstances is very reasonable. W. H. B.

ART. XXIV.—*On Southern New England during the melting of the great Glacier*; by JAMES D. DANA. No. I.

GLACIAL scratches, southeastward in direction,* on the Taconic summit, Mt. Everett, in the southwest corner of Massachusetts, at a height of 2,600 feet above the sea, afford evidence that the ice which covered New England in the Glacial period overtopped this mountain, and had an elevation in that region not much under 3,000 feet. Similar facts in the White Mountains place the height there at not less than 5,800 feet.† Calculating the slope of the upper surface of the glacier over New England from these data, it follows that the height above the

* Hitchcock gives the direction S. 18° E. The author observed S. 27° E.

† Prof. C. H. Hitchcock has informed the writer in a letter dated Aug. 13, of the current year, that he has found true transported bowlders on the very summit of Mount Washington; and this may authorize a higher estimate.

region of New Haven, in Southern Connecticut, may have exceeded 2000 feet, and could hardly have been less than 1500. With such facts in view, we may have some appreciation of the amount of material that was at hand, when the melting-time began, for making or deepening under-glacier streams and lakes, and, at last, swelling the waters to universal floods. The sinking of the land that took place after the ice had reached its height—placing the site of Montreal 500 feet below the sea level, making Lake Champlain an arm of the great St. Lawrence Gulf, and carrying other high-latitude lands much below their present level, a movement favoring greatly the wide extension of the floods—presents a reason for the continental change of climate which began the thinning of the glacier and finally hurried on its dissolution. The Champlain or Fluvial period—the period of this low level of the land, or the middle Quaternary—comprises, first, an era well called the *diluvial*, or that of the melting glacier and of the tumultuous floods thus occasioned, and, secondly, the *alluvial*, characterized by more quiet fluvial action. The following observations relate more especially to the earlier of these divisions of the period.

Three prominent facts appear to be established by the Champlain deposits of Southern New England.

1. The occurrence of a vast flood during the closing part of the melting of the glacier, in which other parts of New England participated.
2. The absence of marine life from Long Island Sound through the Glacial period and the early part of the Champlain period.
3. A participation in the subsidence which affected the regions farther north.

I. The flood from the melting glacier.

1. New Haven Region.

Facts proving that a great flood closed the era of melting were brought out by me in my memoir on New Haven Geology, published, in 1870, in the Transactions of the Connecticut Academy of Sciences. Since that paper appeared I have made various additional observations which I think demonstrate its occurrence still more positively, and afford also, some idea of its extent and violence.

In order that the facts may be better appreciated, a map of the New Haven region is here introduced. The region properly includes the country about the New Haven harbor or bay having the eastern slope of the high land of Orange and Woodbridge (100 to 400 feet above the sea) on the *west*, the Mt. Carmel range, nine miles from the city of New Haven, on the *north*, and the hills

of East Haven, east of the bay and of the valley of the Quinnipiac, on the *east*. The rocks of Orange and Woodbridge, adjoining the region, are, like those farther west, metamorphic, being chlorite slate and chloritic hydromica slate; while those underlying the rest of the surface, beneath the Quaternary, are Triassic (or Triassico-Jurassic) red sandstone and conglomerate, with intersecting ridges of trap. The trap ridges include the West Rock Ridge, commencing on the south at W, West Rock proper; P, or Pine Rock; M Wh, or Mill Rock ridge, having Whitney peak as its highest point; E, East Rock; Mt. Carmel to the north; Rt, Rabbit or Peter's Rock; and Saltonstall ridge, just west of Saltonstall Lake. The other hills to the eastward, with a few exceptions, are sandstone hills, or sandstone and trap, with a surface of drift; and between these hills south of Mill, Pine and West Rocks, extends the broad and nearly level New Haven plain, a region of stratified drift. The principal rivers, it will be observed, are three: (1) the Quinnipiac on the east, the largest; (2) Mill River, or the central; and (3) West River, on the west, with Wilmot Brook as a prominent tributary. The Quinnipiac has very broad flats on either side, as the map indicates; and, for the most part, they are not above high tide level all the way to North Haven, six miles north of New Haven. Mill River has a rapid descent from Mt. Carmel to Whitneyville (V, within a mile and a half of the city), and West River is of similar character down to Westville. The long lake above Whitneyville (V), has been made by a dam, 40 feet high, at V. Saltonstall Lake on the east, occupies a natural depression. Height above mean high tide of West Rock at W, 405 feet; of East Rock, 360; of Mt. Carmel, 736; of Rabbit Rock, 373.

The evidence afforded by the deposits of the New Haven region is of three kinds.

1. *Structural:* the flow, when it set in, having made its mark in some places on the structure of the beds it deposited.

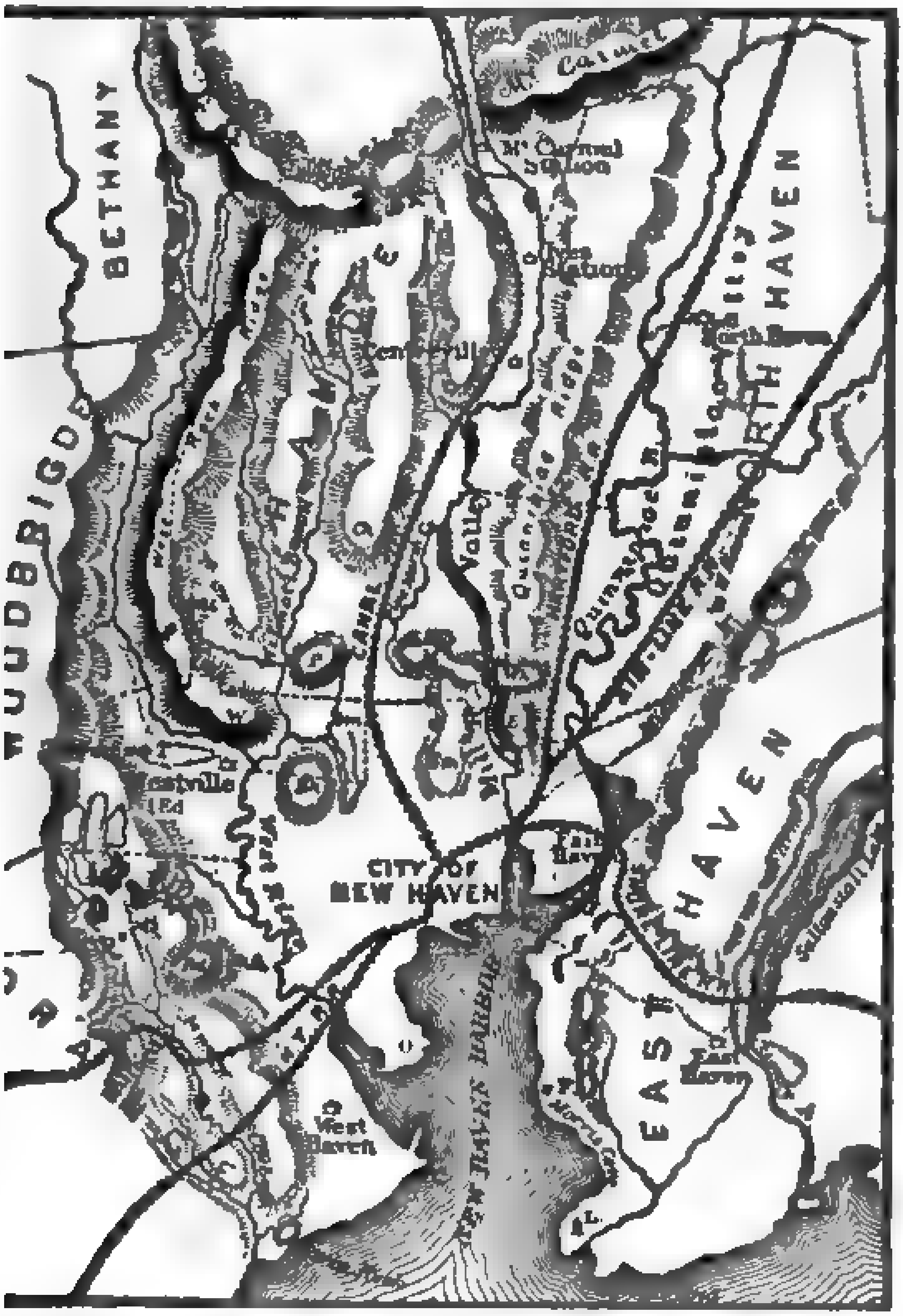
2. *Lithological:* the flood, where the current was strongest, having made gravel and cobble-stone deposits as a topping over the finer beds before laid down.

3. *Denudational:* the flood having produced a large amount of denudation throughout the drift formation.

1. *Structural evidence as to the flood.*—The Quaternary deposits about New Haven bay underlying the New Haven plain are estuary deposits of *stratified drift*. The average height of the upper half of the plain above mean high water level is about 42 feet; from this, there is a slope seaward of 8 to 10 feet a mile. The deposits consist of (1) sand; (2) sand and gravel; (3) rarely, of laminated clay; and in some large regions (4) layers of coarse pebbles and cobble stones.

Over the hills that rise above the level of the plain there is only *unstratified* drift, except along the small water courses.

Map of the New Haven Region.



Explanations of the Map. A, Allingtown village. B, Beacon Hill. Bh, Beaver hills. C, Cherry Hill. E, East Rock ridge, consisting of East Rock proper to the northwest, Indian Head next to the south, and then Snake Rock. Ed, Edgewood, the estate of Donald G. Mitchell. F, Fort Hale. F', Ferry Point, or Red Rock, on the Quinnipiac. J, Judges' cave, on the West Rock ridge. L, Light House. M, Mill Rock. MP, Maltby Park, three of the proposed lakes of which are constructed. O, Oyster Point. P, Pine Rock. Rd, Round Hill. Rt, Rabbit or Peter's Rock. Sm, Sachem's ridge. T, Turnpike; also Tomlinson's bridge across the head of New Haven bay. V, Whitneyville. W, West Rock, the southern end of West Rock ridge. WC, West Cape, or West Haven Point. Wh, Whitney Peak. WL, Wintergreen Lake, just north of Wintergreen Falls. Wo, Warner's Rock. bm, Beaver Pond Meadows. m, Mineral Spring, southeast of North Haven. n1, n2, n3, n4, different notches in the West Rock ridge, n1, n2, the Upper and Lower Bethany notches, n3, the Hamden Notch; n4, the Wintergreen Notch.
Scale 4-10ths of an inch to the mile.

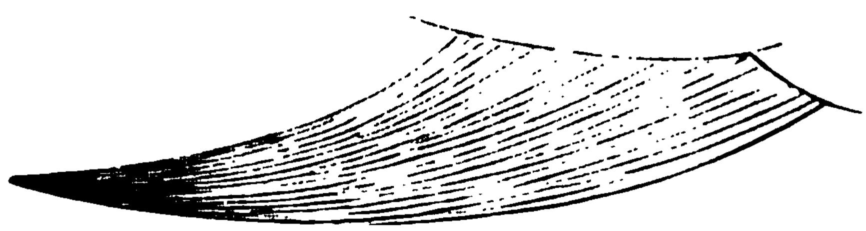
This unstratified drift consists of sand and gravel, with numerous scratched bowlders, without any underlying bowlder clay.

Large bowlders are rarely met with in the stratified drift except near the rocky bottom on which it rests. The Triassic sandstone underlying the New Haven plain in some places approaches within a few yards of the surface of the plain; and when so, the opening of trenches for sewers or other purposes brings to light a layer of gravel resting on the sandstone, which is full of large scratched bowlders, many over a cubic foot in size, and occasionally one over five hundred cubic feet. In the regions of unstratified drift, that is, above the level of the plain, bowlders are many and large, especially along the western margin of the region; and several of trap, are between 500 and 1000 tons in weight.

These facts teach, as I have elsewhere remarked, that, in the melting of the glacier and the accompanying dropping of the earth and stones, the part of the material which fell over the dry land went down *unstratified;* and that which fell into the waters was *stratified*, excepting a bottom portion made of the earth, gravel and great stones that were the first to drop from the ice. There is no evidence that the stratified drift of the plain is newer than the main part of the unstratified drift over the hills.

The stratification of the stratified drift is in almost all parts, except where too coarsely stony for it, of the *flow-and-plunge* style, as represented in the cuts on pages 173, 174. One of the parts of a layer having this structure is represented of the more common form, in the annexed cut, (fig. 1.)

1.



The oblique lamination indicates a violent onward movement in the waters; and the division of the layers into parts proves that there was a heavy plunging in connection with the rapid flow. A single obliquely laminated layer is often one to two feet in thickness, and in one case observed it was eight feet; and each must have been formed at a single onward movement of the plunging waters. This structure of the stratified drift hence shows that water and earth were let loose at the time in immense quantities; that there was a free flow of both which could have been well produced through the melting and discharge of a vast glacier; and that, consequently there was a very rapid piling up of the layers of gravel and sand.

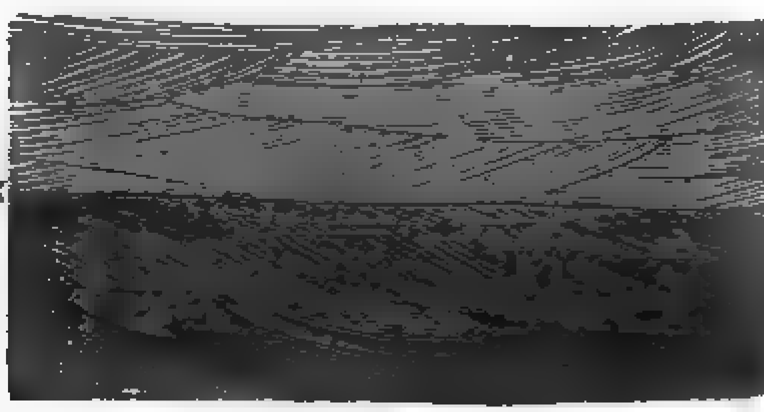
In this oblique lamination which characterizes the deposits of the plain, the little laminæ rise, with only an occasional exception, *to the northward;* that is, dip to the southward, and

e prove that, throughout the New Haven estuary—then six s in depth if we reckon only to Pine and Mill Rocks, and half that in width and opening (as now) to the southward e deposition took place under the pushing and plunging n of the *incoming* tide, the tidal waters having been forced heavier plunging than usual owing to the violent resisting l of fresh waters in front.

his rise to the northward in the oblique lamination (or dip e southward) prevails except at the mouths of the valleys. beds at the lower extremity of the Quinnipiac valley, just heast of East Rock (E), afford one of these exceptions. his place, along the cut of the Air-Line railroad between River and the Quinnipiac, the stratified drift-deposits, which have their full height or 42 feet above high tide level, are sed to view to a depth of about 25 feet. Through the heast half of the cut (near C) where it is within the range he Quinnipiac valley, the beds of the upper 20 feet have oblique lamination *rising to the southward*, that is, in a directhe opposite to that in the underlying beds, and the oppoto that which characterizes the whole thickness of the sit over the New Haven region except at the mouths of valleys. The following cut represents a part, six feet in

2.

N



S

ht, of a vertical section, and shows the plane of junction between the upper and lower portions; above NS oblique nation rises *to the southward*, and below NS *to the northward.* ddition to this difference of direction, the beds below are nish-red, and those above rusty brownish-yellow.

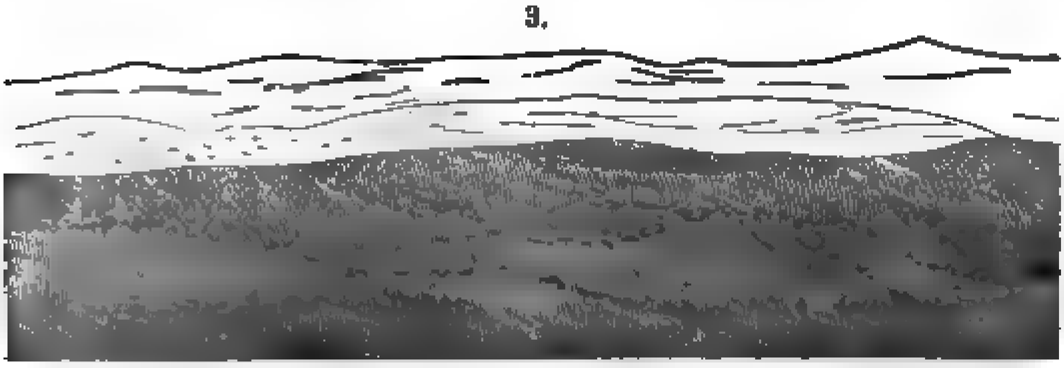
he deposits present this difference above and below for half a along the cut. But passing beyond this westward, or toward River, out of the Quinnipiac Valley, the upper stratum ually loses its distinctive character and becomes like that of plain deposits elsewhere. This change on passing out of range of the Quinnipiac proves that the existence of such ipper stratum was dependent on the flow of the river and on any variation in level or depth, or on any subsequent on of currents. The drift deposits have a uniform level

at top quite to the Mill River channel, and were all one in simultaneous origin.

Now the flow of the Quinnipiac waters must have undergone some change before the last twenty feet of sand and gravel were laid down, and it must have been a change in volume and violence. Owing to this change the current in the river became so powerful as to overcome the action of the incoming tide and take charge itself of the deposition of the earth and gravel. In other words, an extraordinary flood set in, extraordinary even at a time when a violent flood had been already long in progress; and the flood waters did the deposition even in the face of the tide.

Similar evidence of the flood should exist in the other valleys of the region. I have observed it in the valley of Wilmot Brook, near the southeast angle of West Rock (W on the map). The oblique lamination of the upper layer at the place rises to the northward, or dips southward, as at the termination of the Quinnipiac valley, and thus the place bears its testimony to the flood. The same evidence was found nearly a mile higher up the Wilmot Brook valley, where the road turns, at Selden's, to go to Wintergreen Falls and Lake, and the annexed cut represents a portion of the section.

9.

S.  N.

Section of stratified Drift up Wilmot Brook.

Owing to there being no good sections of the stratified drift at the extremities of the Mill River and West River valleys, I have not obtained any facts from these points.

2. *Evidence as to the flood in gravelly and stony formations.*—The material of the stratified drift-formation over a large part of the New Haven region is sand, with only small pebbles where any occur. But adjoining the river courses through the plain, especially Mill River and West River, it consists to a great extent of large pebbles or stones, and much of it of cobble-stones, many of which are six to eight inches in diameter.

The Quinnipiac Valley deposits are an exception, because the wide valley was at the time an interior harbor nearly four miles long and a mile in average width, with North Haven at its head, and much of it was over 50 feet deep. It was hence

a level surface feeling the tides in their full force to its northern limit. Hence the flow of the waters through it would not have been turbulent like that along the streams of rapid descent. That this was the condition of the region is proved by the fact that the region is now one of wet peat meadows flooded at high tides. Further, the height of the stratified drift at North Haven, and at a point four miles below (near E) is alike, being not over 45 feet above the level of the flats.

The West River region shows its stony character strikingly at Westville where it leaves its narrow valley. The stony beds of the deposits follow the course of the stream southward through the New Haven plain either side of the river flats: but the stones diminish in size, at first rapidly, and then gradually, and two miles down the stream there are only pebbly beds with sand; thus showing the slower flow through the estuary of the era.

The stony beds along the course of Mill River are much more remarkable than those of West River, both in extent and coarseness. The area they occupy south of Whitneyville rapidly widens southward, becoming one-quarter to half a mile broad. The coarser part is situated to the east of the present channel of the river; and it extends southward, with a straight course to the head of the bay (south of VEN in the map), where it passes beneath the water to a distance yet undetermined. The beds consist partly of cobble stones 6 to 10 inches in diameter. The coarseness diminishes both to the east and west. On the east side of the river at the State street bridge (which on the map is near M in Mill River), where the stony stratum is 20 feet thick, the stones and pebbles are much smaller in average size than on the west side, and they diminish on going farther eastward.

Since such stony regions indicate where the waters run most violently along their valleys or through the estuary, it is evident that the main flow of Mill River from East Rock (E) southward was to the east of the course it now follows;* and up the same channel moved the great central tidal flow of the harbor. The rushing waters, combining the flow of the river with that of the ebbing tide, carried the finer material down stream, leaving the stones behind; and this finer material was made to contribute to the sandy stratified drift-deposits along the west side of the bay (where the inflowing tide now makes its chief depositions of sand), as well as to the Sound.

Now these stony beds testify to the flood not only by their presence, but more especially by their *belonging mainly to the*

* Just south of the Shore-Line railroad, the coarse beds are wanting for nearly a third of a mile west of Mill River, or to Franklin st., as I learn from Mr. P. Chatfield.

upper fifteen or twenty feet of the formation, and therefore by their being the last work of the melting and discharging glacier. A coarse stony stratum above and fine below is found through all the Mill River stony region.* Along the sections made through the New Haven plain to the level of the river flats in grading the streets, the lower part of the exposed section is mainly of sand, while the upper is gravel and stones. The same has also been found to be true in the excavations for sewers in that part of the New Haven region. At one of these (at the corner of Orange and Laurel streets), the stony stratum was 12 to 15 feet thick, and below it the beds were mostly fine sand, the lower stony layer resting on a bed of fine quicksand. The vicinity of West River presents similar facts.

Such a transition in the drift deposits from the production of sand beds with but little fine gravel to that of beds of coarse gravel and large stones—partly cobble stones—proves that there was an equivalent change in the flow of the waters. These waters were in rapid plunging flow when the lower stratum was deposited; for the beds are characterized everywhere by the flow-and-plunge structure, and a foot is a common thickness for the bed made by a single plunge. But, however great the previous violence there was an increase afterward to a vaster flood.

The partial decline of the flood is also marked in some portions of the deposits by the return to sandy beds in the top portion attending a narrowing of the stony region. On the western margin of the Mill River stony area, in Grove street above its intersection with Church, the stony beds reach the surface for 200 feet above Church street; but from that point westward, the stony portion thins, and in place of its upper beds there are sandy and fine pebbly beds; in 200 feet this upper sandy part has become six feet thick: indicating thus the narrowing of the more violent part of the Mill River flood, as its season passed, or the melting of the glacier became completed.

In the region of the Quinnipiac valley, three to six miles north of New Haven, on both the east and west sides of the present lower flats, there are beds of fine clay, from a few feet to thirty-five or more in thickness. The upper surface is but little, if at all, above high tide level. As this Quinnipiac region was then (in the Champlain period) a great interior harbor or arm of the bay, over fifty feet in depth, still water would have existed on one or both sides of the main flow; and these clay beds, all finely laminated, indicate the positions of such still-water areas. The clay beds, when followed a few scores of yards to one side or the other, sometimes become sand beds—as at Quinnipiac,

* When my Memoir on the New Haven region was written I had not recognized the distinction between the upper stratum and the beds below.

half way to North Haven; and this is demonstration that their existence depends not on the kind of deposits there let fall by the glacier, but on the quiet condition of the waters. There is also proof at Quinnipiac, as brought to my attention by Mr. S. P. Crafts, that the depositions took place before the ice had all melted; for a large bowlder—four feet in diameter—has been taken out of the clay from a depth of six feet, and some intercalations of gravel seem to have had a similar origin. At the same place, fifty feet to the west of the clay pit, a very coarse, stony stratum of stratified drift overlies the clayey stratum; the fact that the latter exists below the stony beds having been ascertained by Mr. Crafts by means of a drill, which descended through and brought up some of the underlying clay. This overlying stony bed was made by violent currents that succeeded to the still waters of the place, and these violently flowing waters were probably those of the great flood.

3. *Evidence as to the flood in its denudation of the stratified drift deposits.*—Along the *west* side of Mill River, where the beds are stony and of the coarsest kind, the plain is 10 feet below the usual level, the height not exceeding 30 feet above the river flats: while on the west side of the river near the State street bridge, where the stony beds are less coarse, the height is 40 to 42 feet—the full height of the New Haven plain in that latitude. The lower level on the west side continues south to the harbor, the surface sloping in that direction. The deposits of stones must have been made largely by the washing away of the finer material from the coarse—a denuding process; and it is reasonable to suppose that the lower level along the west side of the broad Mill River region was thus produced. But the river did not act alone in this; for the river-channel was also, as stated above, one of the sweeping grounds of the tidal waves and currents. Hence it is that this region of low level slopes and widens much southward, extending over half the width of Grape Vine Point (G, between the mouths of Mill River and the Quinnipiac), where the height is reduced to 10–20 feet.

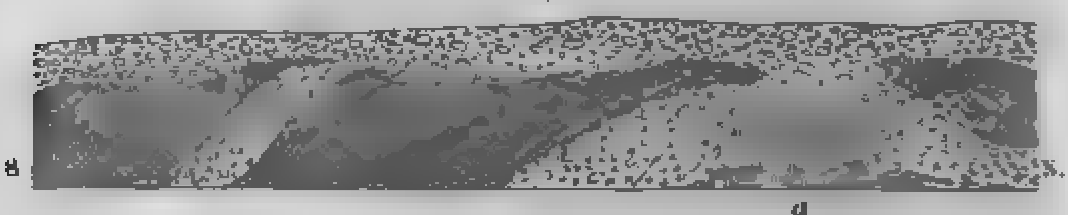
The upper surface of the Terrace plain, near the junction of the Air Line and Hartford railroads, bears evidence of erosion to a yard or so in depth, over large areas of its surface, and of a subsequent deposition of fine sand.

At Quinnipiac the upper surface of the clay bed, alluded to above, has depressions that are results of erosion, and probably the eroding waters were those of the flood that deposited the overlying gravel bed.

A remarkable example of erosion of the drift deposit by the rushing waters of the flood was exposed to view in 1872 on Blake street, directly south of the extremity of Wilmot Brook valley, (on the map between Bl and West River). The follow-

ing cut exhibits at *a* a portion of the previous deposit of fine sand, projecting up and enveloped in the coarse gravel that the tearing waters were bearing along down stream.

4.



Section of stratified Drift on Blake St.

Various depressions over the New Haven plain may be owing to the action of the flood, which cannot now be distinguished from those due to later denudation. But there are some isolated depressions 20 to 25 feet in depth, and one, Beaver Pond Meadows, having an area of an eighth of a square mile which have no such origin. These appear to be mainly due to the deeply excavating action of the ploughing glacier, they having been parts of under-glacial water-courses in the Glacial period; they were excavated to so great a depth that the drift dumped into them by the melting glacier, or carried in by its waters, was not sufficient to fill them, while other shallower areas were built on up to the water's level of the era.

Thus the great flood left its mark not only in the structure and degree of coarseness of the deposits along the water-courses, but also in denudations of the drift-covered surface.

It is to be noted (1) that the upper stony stratum is not found over all the stratified drift of a valley; for through much the larger part of the New Haven region the upper stratum is sand. Such stony beds are to be looked for only where the flood waters ran most swiftly, while beds of fine pebbles, sand or earth exist where they were less rapid, and others of clay where the movement was slight or almost null.

It is to be noted, secondly, that the coarsest stony beds do not always or generally cap the highest terrace; for the fiercely-flowing waters often denuded the surface deeply and left the larger stones at one or more lower levels—levels that are now the upper portion of one or more of the lower terraces; but which, in the era of the flood, were either under-water flats, or else the broad bed of the flooded stream.

If the stony strata may have been merely the stony beds of streams, like the stony bed of any rapid stream in modern time, it may be questioned whether they afford evidence of a flood from the melting glacier. But such a stratum is common also at the top of the upper terraces, where it could have been made only by such a flood. Both Mill River and West River val-

rs afford examples of this. Again, since the Champlain posits that lie *beneath the stony beds* are made of fine material, ere is full evidence, whether the latter were formed over the d of a stream or at higher levels, that an era of comparatively iet work was in each case *followed* by one of coarse stony positions, and hence that there must have been an increase the flow at the last. The Glacial period scooped out the lleys and deepened them, and then came the filling from e unlading glacier; after the bottom had received part of e large bowlders that fell from the ice, there followed the position of sand and finer gravel, with clays in some places, d occasional bowlders; then, finally, the upper coarse beds re formed wherever the waters at the flood could carry off e finer material or carry in coarse.

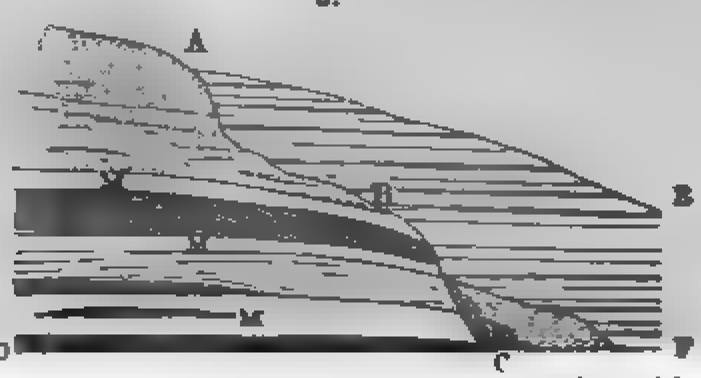
The beds of gravel and cobble stones along Mill River extend r more than two miles through the New Haven plain, or at was then the great estuary, where there was no cause for pid flow in the stream apart from a flood of enormous extent eeping down the valleys.

Depositions subsequent to the flood.—It may be questioned ether the flood-made upper stratum in the vicinity of the river urses, which has been above described, may not have been posited during some flood, or era of glacier melting, later an that of the early Champlain period closing the era of the eat glacier. The evidence against such a supposition in the calities which I have examined is decisive. For, as I have own, this upper stratum when followed laterally away from e river courses, changes into the ordinary stratified drift; or, other words, the very same stratum bears the flood-marks ar the river courses, and not so, or only sparingly, over other gions. The stratified drift of the New Haven region is evi- ntly all one formation; it is one in structure, even to its top yer. All of later origin ordinarily overlying it is about a ot or less of blackish soil; and this is simply a portion of its rface sands modified by the growth of vegetation.

There are some portions where its upper surface was irregu- rly eroded, as has been explained, and there the surface was ter built up to the old level by depositions of fine material, sily distinguished in kind from those below, indicative of anged conditions—but only a change from the flood condi- on to that of the more quiet subsequent part of the Cham- in period. The terrace plain near the junction of the Air ne and Hartford railroads has been mentioned as one local- of this. The sands of the later deposit are here whitish, owing that they had been washed of their iron rust. A atified bank of the same sands exists at the northeast end of e same railroad cut (that of the Air Line railroad). The

stratified drift formation here drops suddenly in height, from the 42 feet above high tide level usual there, nearly to the low level of the broad lower flats of the Quinnipiac. The slope thus made was, in the Champlain period, the northward limit of the sand-flat which constituted the south boundary of the great inner harbor. Against this slope, spreading northward, there is situated a horizontally stratified deposit of *fine white* sand, which evidently owed its origin to the beating of the harbor waves against the sand-flat during the quiet half of the Champlain period, that is, after the ice and the flood had disappeared. Its stratification and its relation in position to the true stratified drift is shown in fig. 5, in which ACD is the stratified drift, made up of fine sand beds (M) and pebbly beds, some of them coarse pebbly drift, and AEF the subsequent deposit of white or sea-washed sand. The sands of the

5.



Section of stratified drift and later unconformable Champlain deposit, Air Line Railroad cut.

latter differ from those of the other beds not only in their white color, but also in their greater fineness, and in the absence of all pebbles. Through the washing of the waters against the shores, the sands were not only ground up, but they also lost almost entirely the oxyd of iron that tinges the quartz grains of the stratified drift. Near B, at the foot of the slope ABC, there is a heap of pebbles or stones and reddish sand, which evidently fell down the bank from the layers above when it existed as an exposed slope before the beds of whitish sands were deposited. These whitish sands, moreover, were laid down in even layers, free from the oblique lamination that occurs in the stratified drift. Thus we have evidence of some changes during the Champlain period after the drift was deposited; the wonder is that there is so little of such evidence.

2. Outside of the New Haven region.

Evidence of the great flood produced by the melting of the glaciers is found along all of the rivers of Connecticut upon which I have had an opportunity for making observations.

ı opportunities are not often to be met with, since it re-
es an exposed section of the stratified drift of a valley—and recently exposed, since the surface soon becomes concealed lides down the slope. Moreover, in the narrower valleys ıther rapid descent, the waters were so tumultuous at all s that stony beds were thrown in at all levels. Ten miles ; of New Haven, in the upper terrace of the Housatonic river, eet in height above the flood level in the river, the upper ıum, for twenty to thirty feet in depth, is very coarse y, and mostly sandy with finer stony beds below; and the of a lower terrace is still coarser in its stones. I have ob-
ed similar facts in the Pequonnoc River valley, north of lgeport, Connecticut.

gain, to the east of New Haven, on the Thames at Norwich, upper terrace, at the old cemetery, over one hundred feet re high tide, is exceedingly stony at surface. At the Navy l four miles above New London, on the east side of the mes—where, as elsewhere on that side, there is only a nar-
terrace on account of the crowding rocks—the following ı were presented in a cross section. The height of the ter-
is about 30 feet. At a distance of 40 to 50 yards from the r there is at top a stony layer but two feet thick; and this ı on a horizontally stratified sand-bed.* Passing toward river, the stony portion increases in extent, and also in seness, becoming a cobble-stone bed; and at the river, the le of the formation, so far as in view, was of stones—that is upper three-fourths, the lower part being concealed by the n gravel. Half way to the river along the section, irregu-
ıatches of sand beds, two or three yards in length were in-
ed among the irregular stony layers, after the style repre-
ed in fig. 4, (p. 178). Thus the flood-torn stony features of formation increase toward the river; and some of the sands ıe uprooted sand beds were left in patches among the stones.
ɔ interpret the facts we have to note that the Thames is a wide deep tidal estuary, or rather fiord, fifteen miles long; that, efore, there is no seaward slope to make rapid currents. The er drift deposits, should hence have been of the finer kind, in regular beds; only the extraordinary conditions of a gla-
flood could have occasioned any other result. It must, more-
, have been a flood of enormous volume, with the violence of aract, to have produced, along such an estuary, so extensive ions and cobble-stone deposits. Although I observed no r good section, I think it safe to say, judging from the es which had fallen from some of the layers, that the for-
on, for at least half a dozen miles north of Groton (the

he section in this part showed only four feet of the underlying sand stratum. m yards nearer the river these four feet consisted of large stones and gravel d of sand, being part of the stony stratum alluded to above.

part I examined), was very stony near the river, while mostly free from stones on the side toward the hills.

On the opposite or western shore of the Thames, at Montville, six miles north of New London, where the terrace is one half higher, the facts are even better testimony to the same conclusions. The stony beds occupy a large part of the formation in a bluff close by the river between the shore and the railroad track, while forty yards farther from the river, to the west of the track, they are mostly confined to the upper third or less of the deposits. Further testimony with regard to the extent of the flood in the Thames will be given in another paper.

In a recent journey in Vermont, I found many examples of an upper stony stratum along the valleys. West of Ludlow, the upper stratum of the high terrace on the south side of the valley was coarse stony, while below the beds were mainly of sand. At Sutherland Falls, on the Otter Creek (or River, as it should be called), where fine sand was the main constituent of the formation—being fine enough for use in the marble mill—the upper portion for 8 to 20 feet was very pebbly, the pebbles mostly half to one inch in diameter. Just north of Pittsford, on the high terrace of a branch of Otter Creek, there is a coarse upper bed; and one still more coarsely stony on the terrace 50 feet or more below the highest, while the beds below were comparatively fine; also south of Rutland, in the upper part of the high eastern terrace of Otter Creek valley, especially near the junction with the valley of Cold River, and also with that of Mill River, west of the gap passed through by the railroad to Cuttingsville.

Professor Hitchcock, in his Report on the Geology of Massachusetts, makes the general statement that the material of the upper part of the terraced river formation generally differs from that below in being coarser. He refers on page 361 of his Geological Report of Massachusetts, to the fact, observed by him, that the clay stratum of stratified drift is almost always overlaid by sand, and then adds that, sometimes, toward the top, the clay is interstratified with beds of sand [evidence only that there were transitions from gentle to rapid movements in the waters] and then, above, the clay is absent, and "the sand becomes coarser, until, at the top, frequently small pebbles are found, and other evidences of agitation in the waters."

Conclusion.—If river valleys so widely apart over New England, and so many of them, bear evidence of a flood closing the existence of the glacier, we may reasonably conclude that all New England was, sooner or later as the melting progressed, swept by it. In fact, if the flood in any part was due to the rapid melting of the disappearing ice, it must have been thus universal; for the rapid melting would have been general.

The flood unquestionably preceded the ending of the ice; r, as already stated, only a melting glacier could have af- rded the vast quantities of water required to fill and flood e wide valleys, and have set loose, simultaneously, the im- ense amount of sand, gravel, and stones, that were at the dis- sal of the waters.

The flood appears also to have risen rapidly to its height; r (1) the transition from the finer deposits to the upper coarser atum is generally rather abrupt, and (2) at the lower extrem- of the Quinnipiac valley, the change in the structure of e beds, from tide-made to flood-made, marked in the reversal the oblique lamination, (page 173) took place along a well fined plane without any alternations, and was visible also in e color of the deposited sands.

Finally, the flood was a natural termination of that winter of nters: especially as the rigors of the Glacial climate had ssed, and a lower level of the high-latitude lands was bring- g on a time of warmer climate than the present—the era ien even Britain was occupied by wild beasts of the warm nperate zone.

RT. XXV.—*On the Mechanical Work done by a Muscle before exhaustion, and on the "Law of Fatigue;"* by the Rev. SAMUEL HAUGHTON, M.D., Trinity College, Dublin.

IN the February number of this Journal, for the present ar, a paper is published by Professor F. E. Nipher, contain- g experiments to illustrate the mechanical work done by a uscle (or a group of muscles) before exhaustion. In this per Professor Nipher sets aside a former series of experiments a similar kind made by him, without (as I believe) showing y satisfactory reason for depending more upon the latter ex- riments than upon the former. I am informed by a letter om Professor Hinrichs, of the Iowa State University, that th series of experiments were made in his Laboratory, and at, in his opinion, the experiments, which Prof. Nipher claims have warned me against, were, in fact, as good as those he st made. I propose to establish the following propositions in e present paper:

1. That both series of experiments made by Professor Nipher e a valuable contribution to the facts of animal mechanics.
2. That they are not only consistent with the "Law of tigue" proposed by me, but illustrate both that law and my Coefficient of Refreshment."
3. That Professor Nipher's discussion of his own valuable

experiments is worthless, as it is based on an empirical formula, which has no meaning, and leads to no further consequences.

4. That the "Law of Fatigue," which explains not only Professor Nipher's experiments, but so many other experiments also, is entitled to be received provisionally as a law of animal mechanics, and followed up by deduction to its legitimate conclusions.

I shall commence by describing some experiments* of my own, in which the muscles were kept in continued action, and no interval of rest was allowed. This condition is supposed in the "Law of Fatigue," and when it is departed from, a corresponding allowance must be made depending on the "Refreshment" afforded to the muscles during the interval of repose.

The approximate law of muscular action, which I have called the "Law of Fatigue," is thus expressed:

"*When the same muscle (or group of muscles) is kept in constant action until fatigue sets in, the total work done multiplied by the rate of work is constant.*"

I instructed a number of medical students, chosen at random, to raise dumb-bells of varying weight, one in each hand, in the transverse plane with hands supinated, and raising and lowering the weights in equal times regulated by the beat of a pendulum. This process was continued until the distress of the fatigue produced became intolerable, and the number of times each weight was lifted was noted. The students were required to count one, two, in time to the beat of the pendulum, so as to prevent them from counting the total number of lifts of the weight. Professor Macalister assisted me in these experiments, and one of us counted the number of lifts, while the other compelled the experimenter to observe the conditions of the experiment, which were—

1. To keep time with the pendulum.
2. To raise the weights in the transverse plane.
3. To supinate the hands.
4. To abstain from all bending† of the knees or spinal column.
5. To lower the weights so as to come down without velocity.

The 2nd, 3d, and 4th conditions are essential in order to confine the work done strictly to the same muscles of the shoulder, arm, and forearm.

The experimenter must be carefully watched in order to ensure the observance of these conditions; for he is impelled, instinctively and unconsciously, by pain, to bring in other

* These experiments were communicated by me to the Royal Society on the 17th of June, 1875.

† To this defect we gave the name of "slinging."

muscular fibers to aid those which are suffering from the constrained and regulated motion. If this be permitted, the "Law of Fatigue" will appear to be violated, for of the muscular fibers actually employed in doing work some are quite tired out, and others not; whereas the "Law of Fatigue" applies only to groups of muscles, all of which are completely exhausted. For each experiment I chose twenty students at random, using altogether about fifty different students, and no individual was experimented on again until an interval of forty-eight hours had elapsed. The object of this arrangement was to avoid the effects of "training."

In all cases there were three well marked stages:

1. The work done with ease.
2. Accompanied by respiratory distress.
3. Accompanied by pain in the muscles used.

During the last stage, great care must be taken to prevent changes in the posture and mode of motion, by which additional muscular fibers may come in aid of the fibers nearly fatigued.

Let W denote the total work done, and T the time of doing it; then, by the "Law of Fatigue,"

$$\frac{W^2}{T} = \text{constant.} \qquad (1)$$

If w be the weight held in the hand and α be half the weight of the arm, and n the number of times the weights are lifted: Since the time of raising and lowering the arms is constant, n is proportional to T, and the "Law of Fatigue" gives us the formula

$$(w+\alpha)^2 n = A, \qquad (2)$$

where A is an unknown constant.

In the following table I give the values of w and the mean value of n for 20 distinct persons.

The time of lift is in all cases *one second*.

TABLE I.—MEAN OF TWENTY EXPERIMENTERS.

No.	w.	n (obs.)	n (calc.)	Diff.
1	2·50 lbs.	131·80	128·0	+3·8
2	4·25 "	87·55	78·3	+9·2
3	5·87 "	47·35	53·5	−6·2
4	6·87 "	40·25	43·7	−3·5
5	7·75 "	34·60	37·1	−2·5
6	9·75 "	27·15	26·8	+0·3
7	14·00 "	17·20	15·4	+1·8

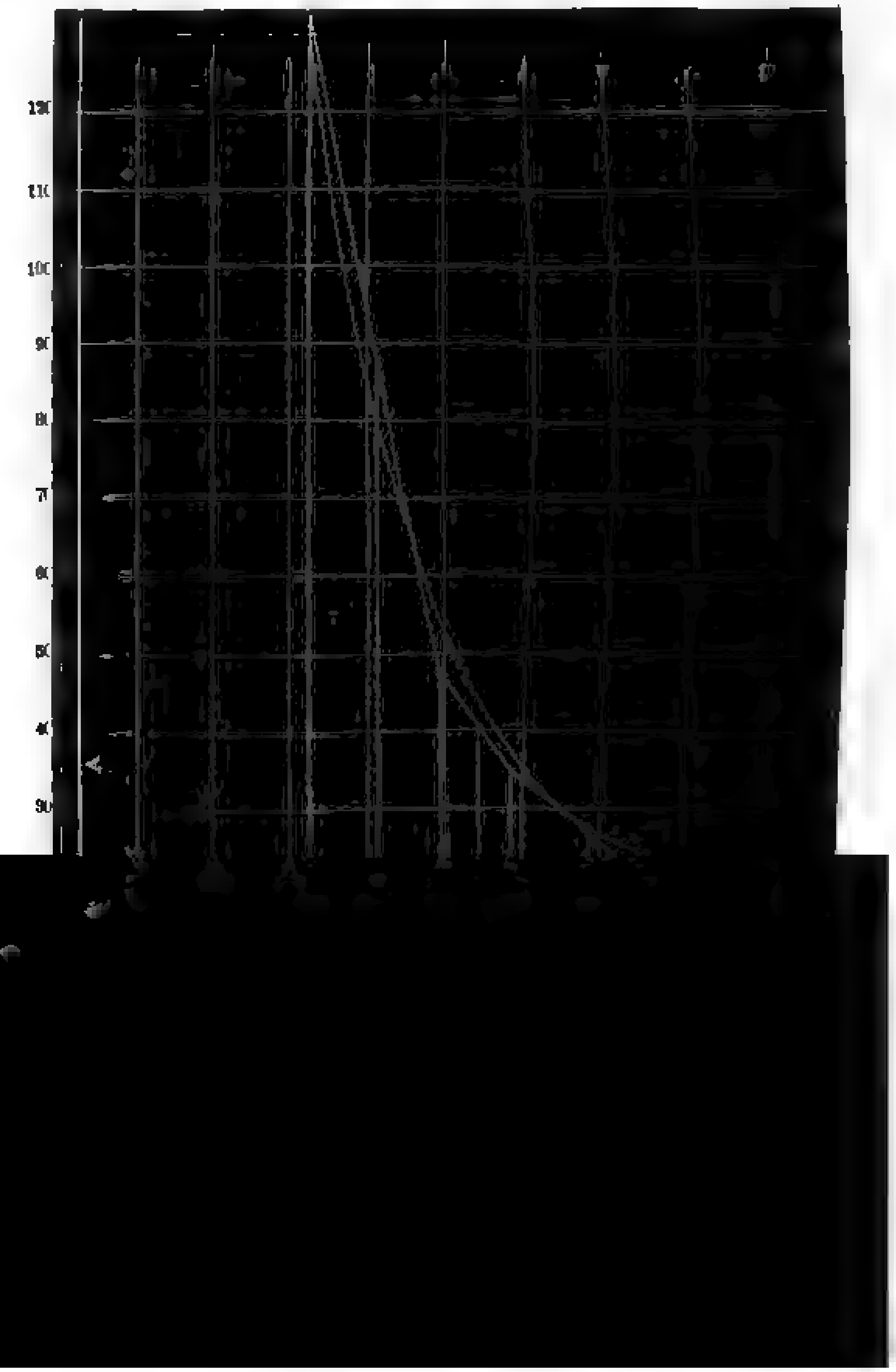
The column containing the calculated values of n was obtained from equation (2) by using the values

$$\alpha = 3·50 \text{ lbs.}$$
$$A = 4699 \text{ "}$$

These values were obtained by finding the value of α, which renders A most nearly constant, or

$$\frac{\delta A}{A} = \text{minimum}.$$

This table gives 7 lbs. for the mean weight of the arm of all experimented on, a result which accords with known facts.



e elsewhere* shown that the Law of Fatigue corresponds ıer experiments based on different data.

: consider the *useful* work only, we have from equa-

$$\text{Useful work}=wn=\frac{Aw}{(w+a)^2}. \qquad (3)$$

equation represents a cuspidal cubic whose ordinate ıaximum value, when $w=a=$ half the weight of the

foregoing observations are in accordance with this de- , as may be seen from table II.

TABLE II.—USEFUL WORK.

No.	w.	wn (20 experimenters).
1	2·50 lbs.	338
2	4·25 "	372
3	5·87 "	277
4	6·87 "	276
5	7·75 "	268
6	9·75 "	264
7	14·00 "	241

ssor Nipher has published two series of experiments, n the principle of lifting different weights at a *constant* ıd both series can be interpreted by means of equation : shall now show.

ıs published other experiments based on the principle ng the same weight at *varying* rates: these experiments only abandoned by himself, but contain internal evi- f error; for both these reasons I shall abandon them, el bound to maintain Professor Nipher's first series at rates against his own repudiation, and as being, on ɔr Hinrich's evidence, at least quite as good as those le by him.

ssor Nipher's experiments differ in two respects from ade by me, tables I, II.

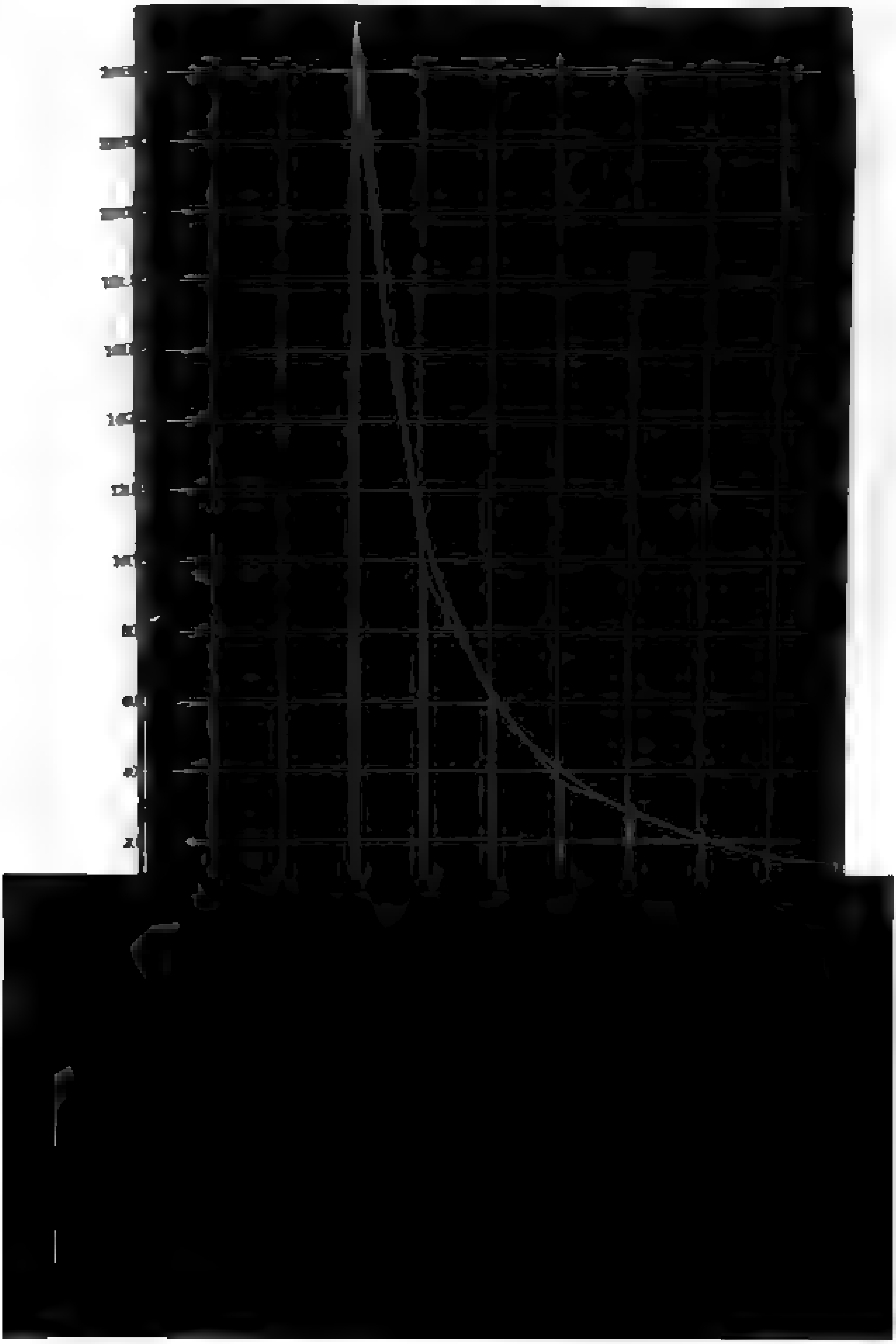
ofessor Nipher allowed a *rest* equal to the time of *work*, ; in my experiments, the work was incessant, as the ıe down without velocity.

om the mode of lifting the weights, there was a greater lity of other muscles assisting those intended to be l.

irst of these causes would refresh the muscles and ena- n to do more work than if not rested at all; and the ɔf these causes would bring in other muscles to their appear to make them do more than their proper work.

* Principles of Animal Mechanics, London, 1873.

Let x represent the unknown weight held in the hand which would represent the total effect, both of *refreshment by rest*, and *aid from other muscles.*



.ation (5) accurately represents both Professor Nipher's of experiments at constant rate, as is shown in the fol- ; tables:

TABLE III.—Prof. NIPHER'S FIRST SERIES.

No.	*w.*	*n* (obs.)	*n* (calc.)	Diff.
1	1 kil.	255	243	+12·0
2	2 "	97	109	−12·0
3	3 "	61	62	− 1·0
4	4 "	37·7	39·7	— 2·0
5	5 "	29·3	27·8	+ 1·5
6	6 "	21·5	20·5	+ 1·0
7	7 "	15·8	15·7	+ 0·1
8	8 "	12·8	12·5	+ 0·3

: calculated values of n were found from equation (5), lues of a' and A being found by the principle of least ion of A—

$$a' = 1·5 \text{ kil.}$$
$$A = 1018$$

liagram II, I construct the cubical hyperbola, and show losely the observations correspond with it.
half the actual weight of Prof. Nipher's arm is 1·50 kil., ›ws that in these experiments 0·49 kil. was lifted, by the *hment* derived from rest, and from the occasional *aid* of muscles.

TABLE IV.—Prof. NIPHER'S SECOND SERIES.

No.	*w.*	*n* (obs.)	*n* (calc.)	Diff.
1	3·0 kil.	152·5	145·5	+7·0
2	3·5 "	95·8	93·1	+2·7
3	4·0 "	67·2	64·7	+2·5
4	4·5 "	51·2	47·7	+3·5
5	5·0 "	36·9	36·4	+0·5
6	5·5 "	28·6	28·8	—0·2
7	6·0 "	22·7	23·3	—0·6
8	6·5 "	18·1	19·2	−1·1
9	7·0 "	14·5	16·1	—1·6

: calculated values of n were found from equation (5), ılues of a' and A being found by the principle of least ıion of A.

$$a' = —1·00 \text{ kil.}$$
$$A = \quad 582$$

liagram III, I construct the cubical hyperbola, and show losely the observations correspond with it.
half the actual weight of Prof. Nipher's arm is 1·50 kilos., lows that in this series of experiments, 2·50 kilos. were by the *Refreshment* derived from rest, and from the occa- *aid** of other muscles.

ıcluding, possibly, those of the assistant employed in the experiments.

It is possible to calculate the coefficient of Refreshment from Professor Nipher's experiments by the difference between a and a'. Thus, in his second series of experiments

$$a - a' = x = 2{\cdot}50 \text{ kil.} = 5{\cdot}51 \text{ lbs.}$$

This weight was lifted through 0·70 m=2·29 ft. in 1·25 seconds —the muscles having previously rested for an equal time.

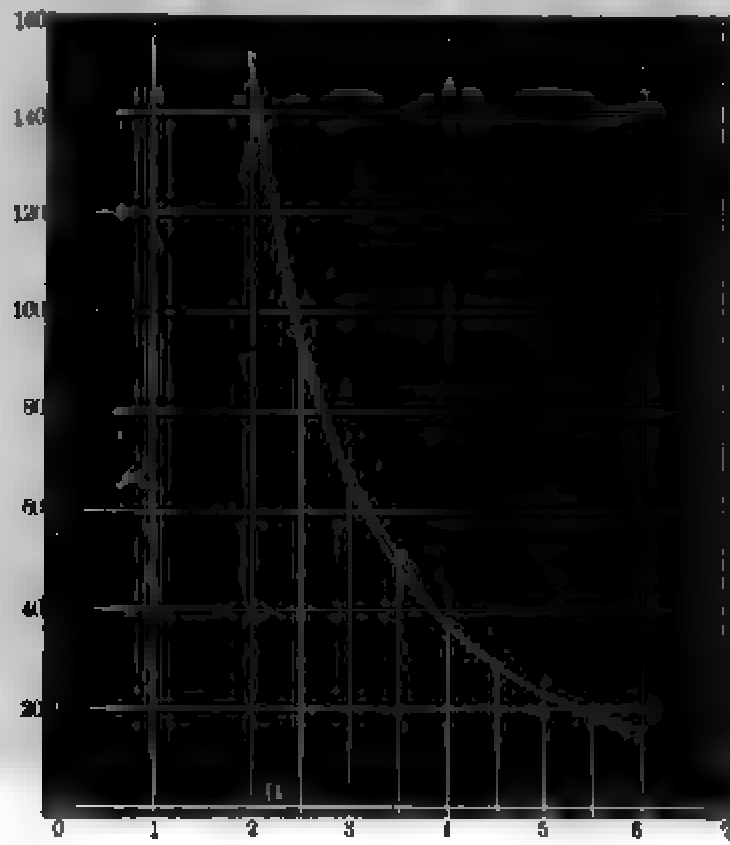


DIAGRAM III.—Prof. Nipher. Second Series.

A, Asymptote $w+a'=0$; B, Asymptote $n=0$.

$(w+a')^2 n = A$. $a' = -1{\cdot}0$ kil. A=582.

Hence, in a cycle of rest and labor of 2·5 seconds duration, half of the time being devoted to rest, the work done, per second, is

$$\frac{5{\cdot}51 \times 2{\cdot}29}{2{\cdot}5}$$

and, assuming 34·5 oz.* of muscle employed, so as to reduce the coefficient to the units employed in my Animal Mechanics; we have finally

Coefficient of refreshment$=\dfrac{5{\cdot}51 \times 2{\cdot}29}{34{\cdot}5 \times 2{\cdot}5} = 0{\cdot}142$ ***ft. lbs. per oz. of muscle per second.***

The coefficient of Refreshment* given, from totally different experiments, by me, is

0·132 *ft. lb. per oz. per second.*

* Principles of Animal Mechanics, pp. 482, 484.

XXVI.—*Notes upon the Earthquake of December*, 1874; by Professor DANIEL S. MARTIN.

the night of Thursday, the 10th of December, 1874, ›ccurred, in and around the city of New York, a slight, ry distinct, earthquake shock, which caused considerable nent at the time, and furnished material for a brief sen- in the papers of the metropolis. On the succeeding .y, the New York Lyceum of Natural History appointed nittee to collect information from every attainable source ırd to the shock and all attendant circumstances. Of ›mmittee the writer was chairman, and in that capacity gaged for the next three months in collecting, arranging ıdying the information gained.

›rief circular was prepared, announcing the committee's tment by the Lyceum, and requesting all persons who ıowledge of the facts to send information in regard to all of the following points, viz: 1, the place of observation, s height above tide water, if known; 2, the time of the ; 3, the duration of the shock; 4, the nature of the ı felt; 5, the direction of the motion felt; 6, any other bserved.

› circular was first published in the principal daily papers city, with an added request that it be copied by local ls throughout the region affected. One thousand copies hen printed, and these were sent wherever there was any ct of advantage.

›ut a hundred responses were received, varying of course ʳ in their character: in the main, however, they furnished and excellent data, which were afterward carefully tab- . Though almost all written by unscientific observers, e incidents and impressions were related in most cases care and clearness beyond what was anticipated, while of the letters were exceedingly vivid and detailed.

ɔourse the main objects aimed at were, the determination geographical extent of the disturbance, of the rate and ·ection of its motion, and if possible, through these, of its ɛimate depth.

first end, as might have been expected, was pretty ʳ attained. The geographical range was determined with ›le accuracy, and found far wider than at first supposed. second inquiry, however, was soon seen to be almost ss of result, from the uncertainty in regard to accurate Local time and railroad time, errors of ordinary time- and errors of observation, complicated also with a differ- f longitude corresponding, between the extreme east and

west points, to some four minutes of time, presented together a mass of uncertainties that might defy the powers of an abler committee to unravel. It was hoped that astronomical time might be obtained at some points, sufficient to fix a definite basis for averages and calculations, but such was not the case. The most that could be ascertained was that the shock occurred at about 10.25 P. M., throughout the entire district affected. The absence of any indication of a progress in time, together with other facts to be referred to directly, speedily led to the idea that the movement had its source at a very considerable depth, and was by no means local or superficial.

The shock was felt from a little beyond Fishkill Landing, Dutchess County, New York, southward to Sandy Hook lighthouse, a distance of some 80 miles. In an east and west direction, it extended from Morristown, N. J., at least to Stamford, Conn.; some of the newspaper accounts reported it as far east as Norwalk. This would give a total extent in this direction of from 54 to 62 miles. It traversed, in this area, portions of the gneiss of the Blue Ridge, the limestones of Westchester County, the "Atlantic" or "Montalban" gneiss of New York and Connecticut, the Cretaceous and drift of Long Island, and the Trias and trap of New Jersey. Its geological relations are in some respects curious and interesting. The fact is very noticeable, that the movement was felt far more strongly and frequently on rocky than on soft ground,—the latter seeming to produce a cushion-like effect, softening or modifying the shock. This circumstance is quite unusual, and is one of the indications pointing to a deep-seated source. In the San Francisco earthquake of some ten years ago, for instance, buildings situated on made ground were severely damaged, while those on the hills were uninjured. But the reverse condition obtained here, as is proved by many letters, and strikingly shown on the committee's map. The crowded observations in the metamorphic region of New York and Westchester, are in singular contrast to the few and scattered points laid down on the heavy drift of Long Island and the Trias of New Jersey. In the main, the shock seems to have been limited by the Highlands of New York and New Jersey,—the continuation of the Blue Ridge,—but four distinct observations, at as many separate points, near Fishkill Landing, show that in that vicinity it crossed the entire series of these lofty hills. Thence the line of observations follows through and along the Highlands by Garrison's (opposite West Point), Stony Point, and Ramapo, New York, to Morristown, New Jersey. Passing eastward across the thirty-mile belt of Trias and trap, scarcely an observation appears, until near the rear (or inner) edge of the great Palisade range of trap, when numerous reports began to come

along the line of the Northern Railroad of New Jersey. ɔe over the Hudson, in the metamorphic region of New rk and Westchester Counties, the shock was felt every- ɜre, especially in buildings founded on rock, as stated by ıy observers. On Long Island, the northwestern edge is iss, from Astoria to Greenpoint, and there the shock was ; but over the great drift-covered portion to the east, under- ı probably by Cretaceous beds, the observations are few and between. Four points are reported in the heart of the city 3rooklyn—all within a circle of half a mile across; and this : would suggest that a ridge of rock perhaps approaches the face at that point, though none is known to appear.

ʟs regards the direction of the wave-movement distinctly orted by many observers, great difficulty was found in ɔhing any result. The accounts were most diverse and n contradictory, indicating a great amount of "personal ation" to be allowed for. From various sources, however, 'as judged pretty clearly that the course must have been rly from southwest to northeast, or upward *along the line of ke* of all the rocks of the region. The main sources were, a small majority of the reports; (2) one very minute and ›ful observation in the upper part of New York City, in ch the circumstances, detailed by Mr. J. W. Rhodes, seem to admit of doubt. In a house fronting south on 113th et, "the sound approached from the south with a *crescendo* vement As it struck the house the front windows rattled lently. About the middle of the room the sound, or shock, arently reached its full volume, and then receded with a *inuendo* movement. The rear windows rattled precisely as se of the front." (3) The direction of cracks in the ground. s effect was reported only at Closter, New Jersey, by Mr. L. Turnure, who kindly furnished a plan of the ground. o narrow cracks appeared, of considerable depth, each on a ;inct road, and both having a direction west-northwest and t-southeast, or transverse to the supposed line of movement.

[he duration of the shock was very variously estimated different observers. It is quite possible that it may have ied with the nature of the ground; but in general it would m to have averaged about ten seconds.

[he general phenomena presented nothing peculiar. A loud ɑbling sound, a heavy jar, and in some cases a distinct ve-motion, were the chief features. In a few places bells ɾe rung, clocks stopped, and cracks opened in the ground, ıbove. In only one case was the shock reported as felt on water,—on a schooner in the harbor of New Rochelle. ry fortunately, the movement just stopped short of doing

any serious injury to buildings or property, though it caused much alarm and excitement for a time in various places, both to animals and men.

The night was calm, mild, and somewhat cloudy, with no meteorological phenomena in any respect noteworthy. Several persons who had experienced earthquakes in South and Central America, referred to an intense and peculiar stillness of the atmosphere, just prior to the shock, which they had been wont to notice in a like connection in the tropics. This circumstance is one frequently reported, and it may be worth mentioning here.

It remains to speak briefly of certain other circumstances, which suggest some interesting conclusions.

From several observers, few indeed, but widely separated, and too many to admit of error, accounts were received of one or more later shocks, at about two o'clock the same night.

Two remarkable letters were sent to the committee, detailing a marked disturbance of very similar character in eastern Massachusetts, on the same afternoon between 5.30 and 6. This shock was felt at North Andover and at Salem, and in both cases by several members of a household. Inquiries from Professor Packard of Salem, and Professor Hitchcock of New Hampshire, and notices in the local papers, kindly inserted by the former, failed to elicit any further information on this interesting point.

In "Nature" (Dec. 31st, 1874), a brief account is given of an earthquake shock experienced by three travelers who were passing the night on the Pic du Midi, a lofty summit of the Pyrenees. It occurred at 4.45 on the morning of Dec. 11th; and "Nature" remarks its almost exact coincidence in time with the shock felt in North America.

These several reports, scanty though they are, made a strong

:. XXVII.—*Contributions from the Sheffield Laboratory of* 'ale College. No. XXXVI. — *On some interesting Equine* alculi; by R. H. CHITTENDEN, Ph.B., Assistant in Physio- gical Chemistry.

r the latter part of April, 1875, a mare, the property of Mr. L. Baldwin of Milford, Conn., was taken sick apparently i colic. One peculiar feature of the case was that all pas- : of solid excrement ceased. After a few days the animal . A post mortem examination was made and in the intes- about one foot from the stomach, was found a calculus ing up the passage completely. In the stomach was found her calculus of the same appearance, but a third larger. ear previous to this the animal was taken sick in the same ner, and as a result of treatment passed a calculus differing i the others only in size, being somewhat smaller. Through kindness of Mr. Baldwin, I was able to obtain these calculi examination. The following is the result: The smallest ilus was perfectly smooth, nearly round and of light-brown r, its nucleus was a small pebble around which the material arranged in concentric layers, preserving the form of the eus. A short distance from the center was a small, loose, gular layer of organic matter, seemingly pieces of chaff, etc. remaining portion was hard, compact and divided into a titude of layers by slight shades of color. The weight of two halves together was 213·22 grams. The calculus found ie stomach was of a yellowish brown color, its surface was :red with broad veins of a light yellow intermixed with ow ones of a darker shade; it was nearly round, its circum- nce one way being 11½ inches, the other 11¼ inches, its weight 679·6 grams. The calculus found in the intestine and which ed the death of the animal, weighed 441·57 grams; its nu- s was a thin and narrow piece of iron half an inch long. ansverse section revealed the same internal structure as the :r, except that in this there was an extra spot of hair-like ter in the compact layer about the nucleus. The surface of calculus, like that of the others, was perfectly smooth. On turing half of this calculus it separated readily into four inct and regular layers, each of which was made up of smal- ones which could not be separated. On dissolving the sub- ce in cold dilute nitric acid, a pale yellow fluid was obtained a residue made up of organic matter, with a little silica. a trace of uric acid was found in any of the layers. The or outer layer was nearly ⅛ of an inch thick; its specific ity was 1·72. The second layer was $\frac{5}{16}$ of an inch thick, i a specific gravity of 1·69. The third layer was ¼ of an inch

thick, specific gravity 1·66. The nucleus portion measured one way 1 $\frac{5}{16}$ inches, the other way 1¼ inches; specific gravity 1·71. While the three outer layers were yellowish-brown the nucleus portion was dark-brown, making a distinct contrast in color. The following are the analyses of the different layers;

	1st layer.	2d layer.	3d layer.	Nucleus portion.
P_2O_5	28·10	28·14	28·34	28·14
MgO	16·84	16·87	16·88	16·58
$(NH_4)OH$	12·57	12·59	12·61	12·61
H_2O	41·72	41·80	41·66	41·96
Residue insol. in HNO_3	·74	.58	·58	·60
	99·97	99·98	100·07	99·89

On igniting the substance at a red heat all the water and ammonia was driven off, thus giving the amount of these two substances. Then determining the ammonia directly by means of magnesia and deducting from the total volatile matter the amount of water was thus indirectly obtained.

These analyses show that this calculus is composed principally of ammonio-magnesian phosphate, and that the different layers are essentially the same. By making thin and polished sections of the different layers and examining them under the microscope with a half inch objective, they were found to be amorphous, but divided into layers by what seemed to be fine black lines, and on examination with a fifth of an inch objective these lines were resolved into fine black specks which may be looked upon as impurities in the phosphate, with regular arrangement, and which are insoluble in nitric acid. With polarized light a fine arrangement and display of colors was obtained.

The other two calculi were not at my disposal for analysis, but from their exact resemblance to this in external and in-

[redacted]

No.	Date. 1874.	Hour.	Sky.	Locality.	Bearings.	Nature of bottom.	Depth in fathoms	Temperature. (F.) Air.	Temperature. (F.) Surface.	Temperature. (F.) Bottom.
27	Jul. 22			Fisher's I. Sd.	Middle Clump, ¼m. S.E.	Sand and shells,	11–8	65°	64°	62°·5
28				Fisher's I. Sd.	Middle Clump, ¼m. S.S.E.	Sand and shells,	11	65	64	62·5
29				Fisher's I. Sd	West Clump, ¼m. S.S.W.	Sand and shells,	8	65	64	63
30	23	2.53 P.M.		Fisher's I. Sd.	Eel Grass Lt. Ship, ¼m E by W.	Sand and gravel,	7	66	64	62·5
31		3.22		Fisher's I. Sd.	Latimer's Reef, 1m. N.N.E.	Sand, grav., shells,	10½	65·5	62·5	61·5
32		3.59		Fisher's I. Sd.	Latimer's Reef, W.; Napatree Pt., 2m. E.	Sand and rock,	11	65	62·5	61
33	24	10.34 A.M.		Fisher's I. Sd.	Groton Long Pt., ¼m. N E. by N.; N. Hummock Lt., S.W.	Sand and shells,	8	72	66	63
34		11.06	½ Clear,	Fisher's I. Sd.	Between Groton L. Pt. & Sea-flower Reef,	Sand and shells,	7	71	65·5	62·5
35		12.14 P.M.		Long I. Sd.	Race Pt. Rock, 1¾m. E.	Rocks and shells,	50	72	68	59
36		12.41	Clear,	Long I. Sd.	Race Pt. Rock, 2m. E.	Rocks and gravel,	50	68	68	58
37		2.33		Nepeague B.	Off Culloden Pt., L. I.	Sand and mud,	12½	74	66	61
39	27	2.40	Clear,	Fisher's I. Sd.	E. part of Sweeper Ground,	Sand and shells,	4	70·5	66·5	65
40		3.10	Clear,	Fisher's I. Sd.	Hotel on Ram I., ¼m. N E., ½ E.	Sand,	4	68·5	66·5	65·5
41		3.31	Clear,	Fisher's I. Sd.	Ram I., ¼m. N.E.	Sand,	3½	68·5	66·5	65
42		3.58	Clear,	Fisher's I. Sd	Off Middle Clump,	Gravel and stones,	14	68·5	66·5	64
43		4.21	Clear,	Fisher's I. Sd.	Off Middle Clump,	Gravel and stones,	10½	67	66	64·5
44	29	11.00 A.M.	Cloudy,	Fisher's I. Sd.	Eel Grass Light Ship, ¼m S.E.	Sand, grav., shells,	7	----	----	----
45	30	11.10	Clear,	Block I. Sd.	Little Gull I. Lt., W.; Race Rock, N.W.	Sand,	46	76	62·5	57
48		1.15 P.M.	Clear,	Block I. Sd.	Gardiner's Point Light, ¼m. S.	Gravel,	14½	71	66	63·5
49		2.50	Clear,	Gardiner's B.	In Gardiner's Bay, L. I.,	Mud,	6½	71·5	67·5	64·5
50		3.46	Clear,	Gardiner's B.	In Gardiner's Bay, L. I.,	Sand,	4½	72·5	66·5	65
51		4.10	Clear,	Gardiner's B.	In Gardiner's Bay, L. I.,	Gravel,	3	72	66·5	65
52		4.27	Clear,	Gardiner's B.	In Gardiner's Bay, L. I.,	Mud,	6½	69·5	68·5	66
53	31	12.54	Clear,	Block I. Sd.	Watch Hill Light, 3m. N. by W.	Sand,	19	68	66	56
55	Aug. 3	10.30 A.M.	Clear,	Long I. Sd.	Bartlett's Reef Light Boat, 1½m. E. ½ S.	Sand and mud,	22	60·5	64·5	63·5
56		10.56	Clear,	Long I. Sd.	Bartlett's Reef Light Boat, 2½m. E. ½ S.	Gravel and sand,	14	59	64	63
57		11.33	Clear,	Long I. Sd.	Bartlett's Reef Light Boat, 3m E.	Sand, grav., shells,	15½	67	64·5	63·5
58		12.15 P.M.	Clear,	Long I. Sd.	Hatchet's Point, 2m. N.W.	Gravel and shells,	19	61·5	64	63
59		1.00	Clear,	Long I. Sd.	Off Saybrook, Conn.	Sand,	4	67	64·5	63·5

Current No.	Date. 1874.	Hour.	Sky.	Locality.	Bearings.	Nature of bottom.	Depth in fathoms	Temperature. (F.) Air.	Surface.	Bottom.
61	Aug. 4	12.19 P.M.	Clear,	L. Peconic B	Little Peconic Bay, L. I.	Gravel and shells,	7½	66°5	74°	71°5
63		1.16	Clear,	L. Peconic B	Little Peconic Bay, L. I.	Gravel,	7	....	....	72
64		2.02	Clear,	L. Peconic B.	Little Peconic Bay, L. I.	Sand and gravel,	10–13	67	72	71·5
66		3.29	Clear,	Gt. Peconic B.	In Great Peconic Bay, L. I.	Mud and gravel,	5½	67·5	74	72
67		3.50	Clear,	Gt. Peconic B.	In Great Peconic Bay, L. I.	Sand,	5½	68	73	72·5
68		4.09	Clear,	Gt. Peconic B	In Great Peconic Bay, L. I.	Gravel,	4½	66·5	73	72·5
69		4.56	Clear,	L. Peconic B.	Little Peconic Bay, L. I.	Sand and shells,	9½	66	72·5	71
71	5	1.45	¼ Clouds,	Gardiner's B	Gardiner's Bay, L. I.	Sand,	3½	70·5	....	68
73	6	9.35 A.M.	Clear,	Block I. Sd.	Watch Hill Lt. 3m N. ½ W.	Sand,	18	63	63	60
74		11.10	Clear,	Block I. Sd.	Montauk Pt., 6m. S.W. ½ S.	Sand,	17	66	63·2	60
75		12.06 P.M.	Clear,	Block I. Sd.	Block I. Lt., 3m. E.N.E.	Mud and stones,	19½	67	63·5	60
76		12.48	Clear,	Block I. Sd.	Block I. Lt., 4m. S.E. by E.	Sand and mud,	18½	68	64	60
77		1.22	Cloudy,	Block I. Sd.	Block I. Lt., 7m. E.S.E.	Mud,	19	68	64	59
78		2.50	Clear,	Block I. Sd.	Watch Hill, 4m. N.W. ½ N.	Sand,	23	70	64	58·5
79		....	....	Block I. Sd.	Watch Hill, 3m. N.W. ½ N.	Sand and shells,	22	....	....	....
80		3.20	Clear,	Fisher's I. Sd.	West Harbor, Fisher's I.	Sand and shells,	4	74	66·5	65·2
81	10	3.20	Clear,	Fisher's I. Sd.	West Harbor, Fisher's I.	Sand and shells,	3½	74	66·5	65·3
82		....	Clear,	Fisher's I. Sd.	West Harbor, Fisher's I.	Sand and mud,	5½	74	66·5	....
83		....	Clear,	Fisher's I. Sd.	West Harbor, Fisher's I.	Sand and gravel,	5½–2	74	....	....
84		5.13	Clear,	Fisher's I. Sd.	Off Middle Clump,	Mud and shells,	12½	73·5	69	64·7
85	11	....	Clear,	Block I. Sd.	Fisher's I., N.	Sand,	15	75	66	61
86		10.35	Foggy,	Block I. Sd.	Fisher's I., N.	Sand,	8½	75	65·5	62·5
87		11.25	Clear,	Block I. Sd.	Fisher's I., N.	Stones,	8	72	65·5	63
88		11.52	Clear,	Block I. Sd.	Fisher's I., N.E.	Stones,	7½	76	66·5	63
89		12.24	Clear,	Block I. Sd.	Fisher's I., N.E.	Stones and gravel,	6	78	66·5	63·2
90		1.17	Clear,	Block I. Sd.	Fisher's I., N. W. by W.; Race Point, W.	Stones and gravel,	5½	76·5	66·5	63·2
91		2.40	Low fog,	Block I. Sd.	Fisher's I., N.	Sand and shells,	32½	75	66·5	63·5

Current No.	Date. 1874.	Hour.	Sky.	Locality.	Bearings.	Nature of bottom.	Depth in fathoms	Temperature. (F.) Air	Surface.	Bottom.
96	Au. 12	4 14 P.M.	Clear,	Long I. Sd.	Seaflower Reef, 1 m. E.	Mud and sand,	6	72°	67°	64°5
97	13	10.40 A.M.	Cloudy,	Block I. Sd.	Montauk Pt., 7m. S.S.E.; Middle Ground, 1½m. W. by N.	Sandy,	15½	74	65	64
98		11.20	Cloudy,	Block I. Sd.	Montauk Pt., 7½m. S.S.E.	Sand and gravel,	9	71	65	64
99		11.48	Cloudy,	Block I. Sd.	Montauk Pt., 7¾m. S.S.E.	Sand and rocks,	5½	73	65	64
100		12 45 P.M.	Cloudy,	Block I. Sd.	Montauk Pt., 4½m. S. by E.	Fine sand,	19	72	65	63·5
101		1.10	Cloudy,	Block I. Sd.	Montauk Pt., 3m. S. by W.	Sand and shells,	20	72	66	63·5
102		2.15	Cloudy,	Block I. Sd.	Montauk Pt., 2½m. S.S.W.	Stones,	8	72·5	65	65
103		2 45	Cloudy,	Block I. Sd.	Montauk Pt., 2m. W.S.W.	Rocks,	7½	72	65	64·5
104		3 10	Cloudy,	Block I. Sd.	Montauk Pt., 2m. W.	Rocks,	7½	72	65	64·5
105	14	2.45	Clo.&rain	Fisher's I. Sd.	Between Eelgrass Lt. Boat & White Rock,	Sand and gravel,	5½	67	66	64·5
106		....	Clo.&rain	Fisher's I. Sd.	Bet. Eelgrass Lt. B. & White R., 1m. E. by N	Sand and gravel,	6	67	....	....
107		....	Clo.&rain	Fisher's I. Sd.	Stonington Lt., 1m. N.E. ½ E.	Sand and gravel,	5	67	....	....
108		....	Clo.&rain	Fisher's I. Sd.	Eelgrass Lt. B., ¾m. W.N.W.	Rocks,	5½	67	....	....
109	17	3.30	Clear,	Fisher's I. Sd.	Eelgrass Lt. B., ¾m. N.W. by W.	Stones,	7	69·5	67	63
110		3.43	Clear,	Fisher's I. Sd.	Eelgrass Lt. B., 1m. W.N.W.	Sand,	6½–3	69·5	67	63
111		3.49	Clear,	Fisher's I. Sd.	Eelgrass Lt. B., 1½m. W. by N.	Rocks,	5½	69	....	....
112		4.25	Clear,	Fisher's I. Sd.	Stonington Lt., 1½m. E.N.E.	Sand,	4	69	66·5	....
113		5.10	Clear,	Fisher's I. Sd.	Eelgrass Lt. B., 1m. W. ½ N	Stones,	7	70	67	63
114		5.40	Clear,	Fisher's I. Sd.	Eelgrass Lt. B., 1m. E.	Sand,	7½	70	66·5	63
115	18	12.10	Clear,	Block I. Sd.	Mont. Pt. 9m. W.; S.E. end Block I., 6½m. N.E.	Sand,	20	71	66	47·5
116		2 43	Clear,	Off Block I.	Mont. Pt., 11m. N.W. by W.; S.E. end Block I., 9m. N.E. by N. ½ N.	Sand and shells,	25	70	67·5	45·5
117		....	Clear,	Off Block I.	Same as last,	Sand and shells,	23½	70	....	....
118		....	Clear,	Off Block I.	Same as last,		23½	70	....	....
119		3.37	Clear,	Off Block I.	Old Harbor Point, 5m. N.	Sand and stones,	11	....	67	55
120		....	Clear,	Off Block I.	Old Harbor Point, 5m. N.	Sand and stones,	11	70	....	
121		4.38	Clear,	Off Block I.	Off New Shoreham,	Gravel and stones,	14	70	66	57·5
122		5.00	Clear,	Off Block I.	Off New Shoreham,	Sand and gravel,	18	70	66·5	62·5
123	19	9.00 A.M.	Clear,	Off Block I.	New Shoreham, 6m. N.W. by N.	Sand and gravel,	14	73	66·5	54

Current No.	Date. 1874.	Hour.	Sky.	Locality.	Bearings.	Nature of bottom.	Depth in fathoms	Temperature. (F.) Air.	Surface.	Bottom.
124	Au. 19	9.37 A.M.	Clear,	Off Block I.	New Shoreham, 6m. N.N.W.	Coarse sand,	14½	73°	66°	50°·5
125		10.37	Clear,	Off Block I.	Block I., N.W.	Gravel,	14½	69·5	66·5	53
126		12.34 P.M.	Hazy,	Off Rhode I.	Point Judith, 4m. N.W.	Sand and gravel,	13½	75	67·5	54·5
127		1 10	Hazy,	Off Rhode I.	Point Judith Lt., 2½m. N.	Stones,	9	----	69·5	61
128		1.43	Hazy,	Off Rhode I.	Point Judith Lt., 3m. E.	Rocks and sand,	4	76	67·5	63
129		....	Hazy,	Off Rhode I.	Off Narragansett Beach,	Sand and gravel,	8½	----	----	----
130		....	Hazy,	Off Rhode I.	Off Narragansett Beach,	Gravel and stones,	10½	----	----	----
131	21	11.00 A.M.	Hazy,	Block I. Sd.	Watch Hill Lt., 3m N. ½ E.	Sand and gravel,	21	80	67·2	56·5
132		....	Hazy,	Block I. Sd.	Watch Hill Lt., 3½m. N. by E. ½ E.	Sand,	20	80	67 2	----
133		1.25 P.M.	Hazy,	Block I. Sd.	Watch Hill Lt., 4m N E. by N	Sand,	17½	79·2	67·2	----
134		1.25	Hazy,	Block I. Sd.	Off E end Fisher's I.	Gravel,	9	78	66·5	63·5
135		2.00	Hazy,	Block I. Sd.	E. end Fisher's I., 2m. N.	Sand,	19½	78	67	57·5
136	24	11.45 A.M.	Cloudy,	Napeague B.	Fort Pond Bay,	Mud,	7½	76	73·2	65·5
142	25	3 00 P.M.	½ cloudy,	Long I. Sd.	Off Hay Harbor,	Sand,	4½	70	65·5	64·5
143		3 30	....	Long I. Sd.	Race Point, ½m. S.	Mud and sand,	7½	70	65 5	----
144		3.40	....	Long I. Sd.	Race Point, 1m. S.S.E.	Find sand,	8½	----	----	----
145		4 20	....	Long I. Sd.	Off Race Point,	Rocks,	5½	----	----	----
146		5.30	....	Fisher's I. Sd.	Between E. Clump & Ram I. Reef,	Hard,	7½	74·5	65·5	65
147		....	....	Fisher's I Sd.	Between E Clump & Ram I. Reef,	Hard,	14	----	----	----
148		6 00 P.M.	....	Fisher's I Sd.	Ram I. hotel, W.N.W.	Hard,	7½	----	----	----
149	27	11.17 A.M.	Part clo	Long I Sd.	Off Niantic, Two-Tree I., E.	Sandy,	5	70·5	65	64
154		3.50 P.M.	Part clo	Long I. Sd.	Plum I. Lt., 3m. S E. by E.; Saybrook Lt., N.W. by W.	Gravel,	22	73·5	66	65
155		4.10	Clear,	Long I. Sd.	Same as last,	Gravel,	26	73·5	66	65
157	30	9.14 A.M.	Clear	Off Block I.	Near Coxe's Ledge, Block I., 20m. W.N.W.	Sand, stones, rock,	21	67	62	51·5
158		....	Clear,	Off Block I.	Near Coxe's Ledge,	Rocky,	21	----	----	----
159		9.00 A.M.	Clear,	Off Block I.	Near Coxe's Ledge, Block I., 20m. W. by N.	Rocks and sand,	21	----	----	----
161		1.40 P.M.	Clear,	Off Block I.	Old Harbor Point, 10m N.W. by W., ½ W.	Mud,	34	70	64	52
162		2 00	Clear,	Off Block I.	10m off Block I., near last,	Mud,	34	70	64	52
172	Sept. 3	2 26	Clear,	Off Block I	Coxe's Ledge,	Hard,	21	72·5	62.5	50

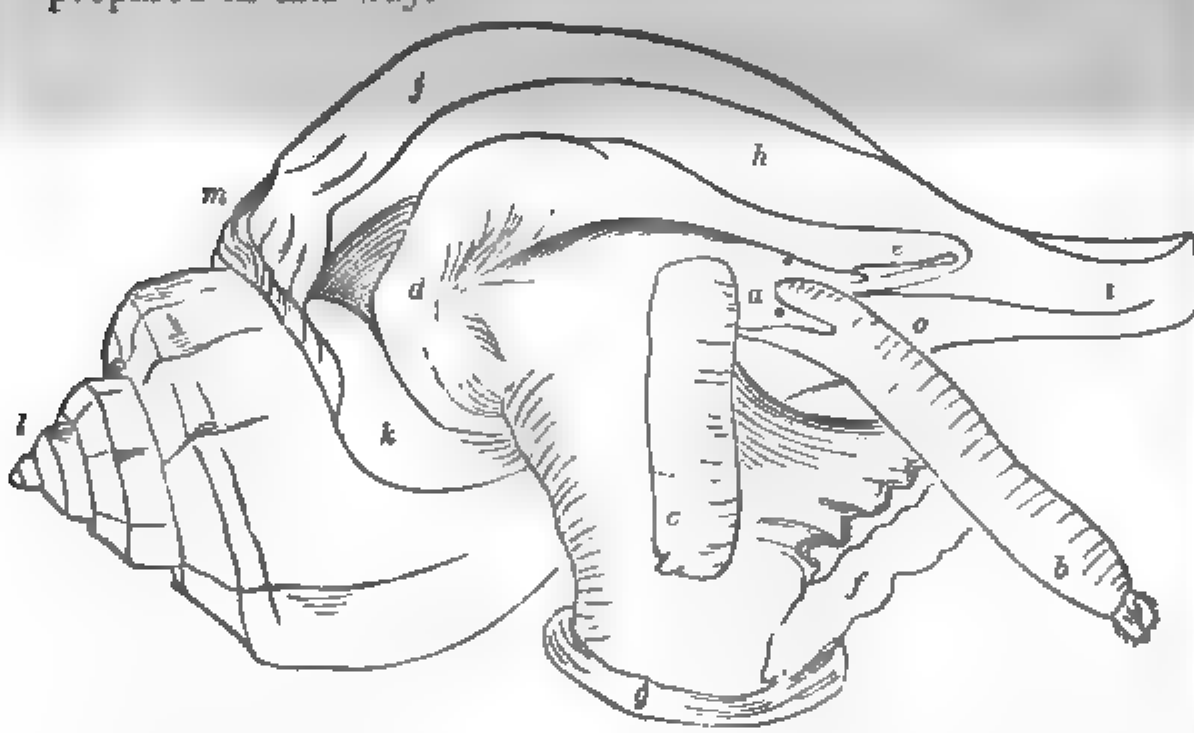
cold current is very apparent as far west as New Haven, in the deeper parts of the sound.* This cold water is doubtless derived directly or indirectly from the arctic current that flows southward along our Atlantic coast; but its flowing into Long Island Sound may be due largely to the influence of the tidal currents, modified by the local wind currents. On the other hand, the much higher temperatures of such enclosed localities as the Peconic Bays may be safely attributed to the direct heat of the sun over a broad expanse of shallow water, from which the cold currents are excluded.

Improved methods of preserving specimens.—During the summer numerous experiments were made by members of the party, but more especially by Prof. W. N. Rice and the writer, to ascertain the effects of various chemical preparations upon marine invertebrates. The special objects were: 1st, to improve the methods of preserving specimens for museum purposes, or to devise new methods; 2d, to ascertain the best means of killing in an expanded state species that ordinarily contract badly when put directly into alcohol. Besides numerous negative results, several of value were obtained. Numerous very perfect and beautiful preparations of *Actiniæ* (chiefly *Metridium marginatum*), in a state of nearly complete expansion, were made by slowly adding a saturated solution of picric acid to a small quantity of sea water in which they had been allowed to expand. When fairly dead they were transferred to a pure saturated solution of the acid and allowed to remain from one to three hours, according to size, &c. They were then placed in alcohol of about 60 to 70 per cent for permanent preservation. The alcohol should be renewed after a day or two, and this should be repeated until the water is all absorbed from the specimen. Hydroids (*Tubulariæ* thus preserved are especially beautiful) and most kinds of jelly-fishes can be easily and beautifully preserved in the same way, but with these the specimens may usually be placed alive directly into the acid, of full strength. Even delicate Ctenophoræ (*Mnemiopsis*, *Idyia*, &c.) can be thus preserved so as to make fair specimens. With osmic acid we did not succeed so well, for the specimens contracted more, and finally became so darkly stained as to render them useless.

Hydro-chloral was also experimented with. It proved to be useless as a permanent preservative of marine invertebrates, as it apparently had a caustic or solvent action, and all the soft parts gradually dissolved, but without putrefaction. It was,

*The following temperatures were taken May 17th, a short distance off the outermost of the Thimble Islands, a few miles east of New Haven: surface 45½°, at 1 P. M., wind southerly, tide 4 hours ebb, sky clear; bottom 43½°, in 5 fathoms, rocks and mud; surface 48°, at 5.30 P. M., tide two hours flood.

however, found very useful for killing certain kinds of animals in an extended condition. It succeeded well, in this respect, with many nemerteans and some annelids, but did not affect all the species alike. Our success with it, in this way, was so great as to encourage us to make many additional trials of this kind during the coming summer. Many experiments were made last season, as in previous years, to find some poison that will kill mollusks, especially Gastropods, in a fully extended state. Although numerous drugs have thus been tried, the results have hitherto been mostly negative. At least, no method has been discovered that is more generally successful than by allowing them to suffocate in stale sea-water, through excess of carbonic acid and deficiency of oxygen. Many excellent preparations of the larger species (*Fulgur*, *Buccinum*, *Natica*, &c.) were thus made last summer. In most cases when the animal was found to be well extended, and at the same time so stupified as to be nearly inactive, the soft parts were forcibly held out by the hand while it was killed by immersion in alcohol. Sometimes it could be tied to the body of the shell so as to keep it from withdrawing when it was placed in alcohol. The accompanying figure was made from a specimen prepared in this way.*



* Figure 1. *Sycotypus canaliculatus*, two-thirds natural size; *a*, head; *b*, proboscis extended, showing the odontophore at the end; *c*, male organ, bent forward, (it is ordinarily bent back under the mantle; in *Fulgur carica* this is a quite different, thin, flat, tapering, tongue-shaped organ); *d*, mantle; *e*, siphon; *f*, lower side of foot; *g*, operculum; *h*, aperture of shell; *i*, canal; *j*, body whorl; *k*, inner lip, *l*, *m*, spire, *o*, columella.

ART. XXIX.—*On the Passage of two Bolides in* 1872 *and* 1874, *over Middle Kentucky;* by J. LAWRENCE SMITH, of Louisville, Kentucky.

THERE have not been, since 1871, any careful observations of the passage of solid meteoric bodies, except in the case of two which came under my immediate observation, both passing over the city in which I reside. The first was on the 12th of December, 1872, just after sunset, and the other on the evening of July 18th, 1874, about 9 o'clock P. M. Of the former I saw only the last remnant of its effects in the atmosphere; the latter I observed in part of its passage and saw it explode.

That of December, 1872, was certainly one of considerable importance, and I have succeeded in collecting not less than fifteen good observations, scattered over a space of one hundred miles east and west, and eighty miles north and south.

At Louisville (lat. 38° 20′ N., long. 85° 25′ W.), just after sundown on the 12th of December, a large red light suddenly appeared in the zenith, and for several seconds seemed to stand motionless, it evidently descending directly in a line with the eye of the observer. Then starting off with an uncertain, faltering motion, it moved slowly toward the horizon, in a southerly direction, gradually fading, in its flight, from a lurid red to a dark purplish hue, and leaving a dense stream of blue smoke behind, which remained for several minutes after the disappearance of the meteorite.

Not many miles from Louisville it is described as an electric flash in a clear sky (with the moon shining and the brighter stars visible), followed in two minutes, by a distant rolling noise like thunder, the reverberation of which lasted for over a minute; and near the zenith, two indistinct clouds were seen, resembling the smoke caused by the explosion of gunpowder.

Another observer, forty miles to the east of Louisville, followed its passage for about twenty degrees. It appeared to him to arise in the west, about ten degrees above the horizon, in the form of a ball of fire, one-fourth the size of the moon, followed by a trail of light which was visible for several seconds and gradually gave place to a well defined line of bluish vapor, which could be plainly seen for three or four minutes. Its passage was accompanied by a distinct noise.

At a place about eighty miles east of Louisville it was seen in a direction almost due west, about 30° above the horizon, resembling a large sky-rocket throwing off sparks, and moving rapidly southward inclined to the horizon; it disappeared about 20° above the horizon, leaving a bright track of smoke,

which was at first very luminous, from its being yet in the light of the sun, that had just before sunk beneath the horizon; but its brilliancy faded as the sun descended lower, and then it behaved like a film of smoke, that was wafted into zigzags by a gentle breeze, curling up in folds and disappearing in about fifteen minutes, going toward the north. After the lapse of four and a half or five minutes, three or four loud detonations were heard in the direction in which the meteor disappeared—the sounds following each other in quick succession, and resembling very closely a rolling of artillery fired very rapidly. From the calculation of this observer, the explosion was located as far west as Louisville, and some thirty or forty miles to the south of this city.

All describe the cloud as remaining for several minutes, slowly breaking up and gradually fading away.

An observer at Danville, seventy miles southeast of Louisville, speaks of its motion as being very much slower than that of the ordinary shooting stars. It left a line of light which lasted but a short time, which had a beaded structure before it disappeared, after which the cloud already mentioned became visible. This observer did not hear any noise; to him it appeared as a viscid body leaving a portion of its mass adhering to the atmosphere as it passed through it, not unlike what we see when a rod is dipped into molten glass, and then withdrawn, leaving a thread attached to the original mass. The thread, however, left by the meteor, did not appear of a uniform size but in places was swollen into knots, and when it was consumed (the thinnest parts disappearing first) it left heavier masses of cloud or vapor at the points where it was thickest. Of these, two were particularly noticeable, as lasting for some minutes after the others had disappeared. They were two or three degrees apart and continued plainly visible for several minutes; and one was seen by this observer for at least ten minutes, and even then disappeared only from the failing light of the evening. The disappearance of the meteor was sudden, not gradual, and the heaviest part of the cloud was not at the point where it disappeared, and the light did not sensibly diminish up to the moment of its extinction.

An observer at Elizabethtown, forty miles south from Louisville, speaks of seeing the explosion, and hearing the report three and a half minutes afterward; by calculation, he located the explosion eight miles south or southwest of Louisville.

Although most observers locate its fall not very far from Louisville, still in this city no one heard any noise such as is produced by the explosion of these bodies. No discovery of any fragments of this meteorite have been made.

I have no comments to make in reference to the passage of this body through the atmosphere, except in connection with the blue or purplish cloud seen by all observers and lasting for no inconsiderable length of time. These clouds are not unfrequently connected with the passage of these bodies through our atmosphere, and are usually more striking in the day time, or, as in this instance, just after sunset, when the sun was well situated to light up the cloud and exhibit it to the observer who could no longer see the sun. What are these clouds? are they composed of impalpable matter abraded from the surface of these bodies in their passage, or are they true vapor clouds? From a close study of observations in connection with several well known falls of meteorites, I am more inclined to adopt the former view; but there is reason for believing that the violent disturbance of a portion of the atmosphere (much of it, in the rapid passage of the body, undergoing great condensation), added to an undoubted electric disturbance of the atmosphere, would tend to the deposition of moisture, upon the atmosphere being gradually restored to its former equilibrium. These, however, are but speculations advanced to draw to the subject the attention of other observers.

The bolide of July 8th, 1874, does not possess equal interest with that just described. Its central point of observation was the same, viz: Louisville. My own observation was made during the last twenty degrees of its course. It was seen by me at 10 o'clock P. M., as a brilliant pear-shaped body, one-third the diameter of the disk of the moon, with a stream of light in its rear, passing in a rapidly descending curve toward the south. When it arrived within almost twenty degrees of the horizon, it burst into three or four separate parts, flashing fourth red and blue lights and instantly disappeared, after the separation, in a southerly direction, the course of its passage being from N.N.W. to S.S.E. I did not hear any explosion at the time of its bursting.

At Franklin, 150 miles southwest of Louisville, it was observed to have a course from north to southwest, and described as being not less than a man's head in size, with a light bluish color, emitting sparks in its course, but no noise was heard until about three minutes after its explosion, when there was a noise like distant thunder. No fragments resulting from the explosion were ever found.

ART. XXX.—*Note on the Gases accompanying Meteorites*; by Prof. J. W. MALLET, University of Virginia.

IN the paper of Prof. A. W. Wright, in the American Journal of Science for July, on the gases obtained from the mixed iron and stony meteorite of Feb. 12, 1875, he remarks that his results "*warrant the following conclusions: 1st. The stony meteorites are distinguished from the iron ones by having the oxides of carbon, chiefly the dioxide, as their characteristic gases, instead of hydrogen.*"

The only specimens of meteoric iron from which, so far as I am aware, the occluded gases have previously been obtained and analyzed, are the Lenarto iron, originally examined by Prof. Graham, and that from Augusta County, Virginia, described by myself.

In the former, hydrogen was the predominant gas, amounting to 85·68 p. c. of the gaseous educt, with but 4·46 p. c. of carbon monoxide and no carbon dioxide; but from the latter I obtained the proportion:

Hydrogen	35·83	
Carbon monoxide	38·33	=48·08
Carbon dioxide	9·75	

So that the oxides of carbon stand to the hydrogen in round numbers in the the ratio 4:3,* and in the paper on the subject read before the Royal Society on May 30, 1872, I drew attention to the fact that this result did not agree with Graham's supposition as to hydrogen being *the* characteristic gaseous ingredient of meteoric iron.†

As to the relative amounts of the two oxides of carbon respectively, I remarked in the same paper:

"*Although it might be assumed, especially in view of the strong tendency of iron to take up and "occlude" carbonic oxide, that this gas had been the original form in which the gaseous car-*

* In the preliminary trial made by Prof. Wright (this Journal, June, 1875, p. 459) the oxides of carbon were found to amount to 49 p. c. of the total gas, agreeing almost exactly with the above; in his account of the more complete investigation (this Journal, July, 1875, pp. 45 and 46) he does not clearly state the absolute volumes of mixed gases obtained at different temperatures, so that it is impossible to calculate the average percentage of carbon compounds for the whole. The arithmetic mean taken from his five analyses is 55·77, but as the larger part of the gas was obviously obtained in the later stages of the heating, and the last three analyses give far less of the oxides of carbon than the first two, this number is doubtless above the true mean.

† I may mention that at the British Association meeting at Brighton, in 1872, Mr. W. Chandler Roberts of the English Mint, formerly Prof. Graham's assistant, orally informed me that the examination of other specimens of meteoric iron, subsequently to the publication of Prof. Graham's well known paper, had yielded results similar to mine.

bon compounds obtained existed in the iron, and that it had in part broken up at the temperature of the experiment into carbon (remaining united with the iron) and carbonic anhydride (which escaped as gas), yet, in view of the steady decrease in the quantity of this latter gas collected as the experiment proceeded and the temperature became higher, and bearing in mind the ready decomposition it undergoes in contact with ignited iron, it seems more likely that a larger amount of carbon originally existed in the iron in this higher state of oxidation than appears from the figures of the analysis."

Prof. Wright's specimen of mixed iron and stony matter was in powder; my specimen was a single solid piece of iron. His was more gently heated at first than mine, and even at the end was not raised to as high a temperature. Both these circumstances would of course facilitate the escape of the carbon dioxide and diminish the chance of its undergoing partial reduction by prolonged contact with strongly heated iron.

On the whole I confess that I cannot look upon the above quoted conclusion reached by Prof. Wright as sustained by the scanty evidence as yet before us.

ART. XXXI.—*Contributions from the Physical Laboratory of the University of Pennsylvania.* No. I.—*A New Vertical-lantern Galvanometer;* by GEORGE F. BARKER, M.D., Professor of Physics.

[Read before the American Philosophical Society, May 7, 1875.]

DESIRING to show to a large audience some delicate experiments in magneto-electric induction, in a recent lecture upon the Gramme machine, a new form of demonstration galvanometer was devised for the purpose, which has answered the object so well that it seems desirable to make some permanent record of its construction.

Various plans have already been proposed for making visible to an audience the oscillations of a galvanometer needle; but they all seem to have certain inherent objections which have prevented them from coming into general use. Perhaps the most common of these devices is that first used by Gauss in 1827, and adopted subsequently by Poggendorff and by Weber, which consists in attaching a mirror to the needle. By this means, a beam of light may be reflected to the zero point of a distant scale, and any deflection of the needle made clearly evident. The advantages of this method are: 1st, the motion of the needle may be indefinitely magnified by increasing the distance of the scale, and this without impairing the delicacy of

the instrument; and 2d, the angular deflection of the needle is doubled by the reflection. These unquestioned advantages have led to the adoption of this method of reading in the most excellent galvanometers of Sir William Thomson. While therefore, for purposes of research, this method seems to leave very little to be desired, yet for purposes of lecture demonstration it has never come into very great favor; perhaps because the adjustments are somewhat tedious to make, and because, when made, the motion to the right or left of a spot of light upon a screen fails of its full significance to an average audience.

Another plan is that used by Mr. Tyndall in the lectures which he gave in this country. In principle, it is identical with that employed in the megascope; i. e., a graduated circle over which the needle moves, is strongly illuminated with the electric light, and then by means of a lens a magnified image of both circle and needle is formed on the screen. The insufficient illumination given in this way, and the somewhat awkward arrangement of the apparatus required, have prevented its general adoption. A much more satisfactory arrangement was described by Professor Mayer in 1872,* in which he appears to have made use, for the first time, of the excellent so-called vertical lantern in galvanometry. Upon the horizontal plane face of the condensing lens of this vertical lantern, Mayer places a delicately balanced magnetic needle, and on each side of the lens, separated by a distance equal to its diameter, is a flat spiral of square copper wire, the axis of these spirals passing through the point of suspension of the needle. A graduated circle is drawn or photographed on the glass beneath the needle, and the image of this, together with that of the needle itself, is projected on the screen, enlarged to any desirable extent. The defect of this apparatus, so excellent in many respects, seems to have been its want of delicacy; for in the same paper the use of a flat narrow coil wound lengthwise about the needle, is recommended as better for thermal currents. Moreover, a year later, in 1873,† Mayer described another galvanometer improvement, entirely different in its character. In this latter instrument, the ordinary astatic galvanometer of Melloni was made use of, an inverted scale being drawn on the inside of the shade, in front of which traversed an index in the form of a small acute rhomb, attached to a balanced arm transverse to the axis of suspension of the needle, and moving with it. The scale and index were placed in front of the condensing lenses of an ordinary lantern, and their images were projected on the screen in the usual way by use of the objective. This instrument is

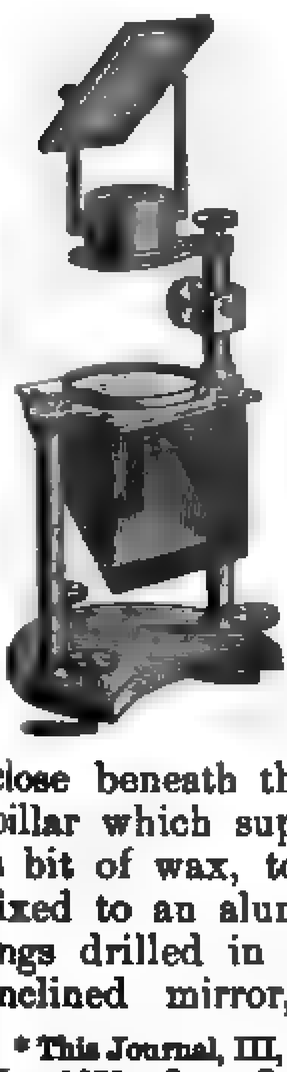
* This Journal, III, iii, 414, June, 1872; Jour. Frank. Inst., III, lxiii, 421, June, 1872.

† This Journal, III, v, 270, April, 1873.

essentially the same in principle as the mirror-galvanometer; but it cannot be as sensitive as the latter, while it is open to the same objection which we have brought against this—the objection of unintelligibility. In the hands of so skillful an experimenter as Mayer, it seems, however, to have worked admirably.

It was a tacit conviction, that none of the forms of apparatus now described would satisfactorily answer all the requirements of the lecture above referred to, that led to the devising of the galvanometer now to be described, which was constructed in February of the present year. Like the first galvanometer of Mayer, the vertical lantern as improved by Morton,* forms the basis of the apparatus. This vertical lantern as constructed by George Wale & Co., at the Stevens Institute of Technology, as an attachment to the ordinary lantern, is shown in the annexed cut, fig. 1. Parallel rays of light, from the lantern in front of which it is placed, are received upon the mirror, which is inclined 45° to the horizon, and are thrown directly upward, upon the horizontal plano-convex lens just above. These rays, converged by the lens, enter the object glass, and are thrown on the screen by the smaller inclined mirror placed above it. The upper face of the lens forms thus a horizontal table, upon which water-tanks, etc., may be placed and many beautiful experiments shown. To adapt this vertical lantern to the purposes of a galvanometer, a graduated circle, photographed on glass, is placed upon the horizontal condensing lens. Above this, a magnetic needle, of the shape of a very acute rhomb, is suspended by a filament of silk, which passes up through a loop formed in a wire stretched close beneath the object glass, and thence down to the side pillar which supports this objective, where it is fastened by a bit of wax, to facilitate adjustment. The needle itself is fixed to an aluminum wire, which passes down through openings drilled in the scale glass, the horizontal lens, and the inclined mirror, and which carries a second needle near

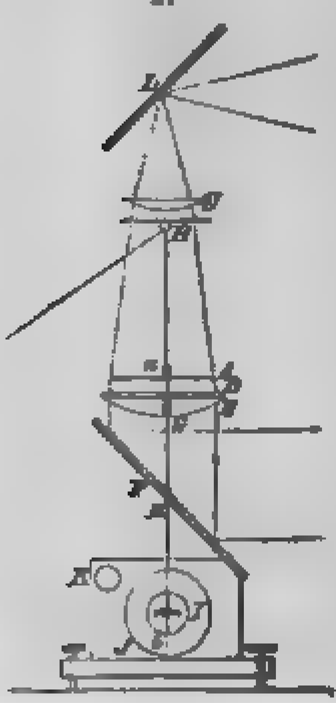
1.



* This Journal, III, ii, 71, 153, July, Aug. 1871; Jour. Frank. Inst., III, lxi, 300, May, 1871; Quar. J. Sci., Oct. 1871. In Duboscq's vertical attachment, which was advertised in his catalogue in 1870, the arrangement is similar, except that the beam received upon the mirror is a diverging one, and consequently the horizontal lens is of shorter focus. A total reflection prism, placed above the object glass, throws the light to the screen. The instrument gives a uniformly illuminated but not very bright field.

its lower end.* Surrounding this lower needle is a circular coil of wire, having a cylindrical hollow core an inch in diameter, in which the needle swings, and a smaller opening transverse to this, through which the suspension wire passes. In the apparatus already constructed (in which the upper needle is five centimeters long) the coil is composed of 100 feet of No. 14 copper wire, and has a resistance of 0·235 ohm. The accompanying cross section (fig. 2) of the vertical-lantern galvanometer as at present arranged, drawn on a scale of $\frac{1}{15}$, will serve to make the above description more clear. A is the needle, suspended directly above the scale-glass D, by a silk filament passing through the loop B, close under the objective C. This needle is attached to the aluminum wire *ab*, which passes directly through the scale-glass D, the condensing E, and the inclined mirror F, at H, and carries, near its lower end, the second needle I. This needle is shorter (its length is 2·2 cm.) and heavier than the upper one, and moves in the core of the circular coil J, whose ends connect with the screw-cups at K. This coil rests on the base of the lantern, enclosed in a suitable frame. It is obvious that when the instrument is so placed that the coil is in the plane of the meridian, any current passing through this coil will act on the lower needle, and, since both needles are attached to the same wire, both will be simultaneously and equally deflected. Upon the screen is seen only the graduated circle and the upper needle: all the other parts of the apparatus are either out of the field or out of focus. Moreover, the hole in the lens is covered by the middle portion of the needle, and hence is not visible. The size of the image is of course determined by the distance of the galvanometer from the screen; in class experiments, a circle eight feet in diameter is sufficient; though in the lecture above referred to, the circle was sixteen feet across, and the needle was fourteen feet long, the field being brilliant.

2.



The method of construction which has now been described,

* After the new galvanometer was completed and had been in use for several weeks, I observed, in re-reading Mayer's first paper, a note stating that the idea had occurred to him of using an astatic combination consisting of two needles, one above the lens and the other below the inclined mirror, the two being connected by a stiff wire passing through holes in the condenser and the mirror. The plan of placing the coil round the lower needle does not seem to have suggested itself to him. Indeed, it does not appear that the arrangement he mentions was ever carried into practical effect.

is evidently capable of producing a galvanometer for demonstration, whose delicacy may be determined at will, depending only on the kind of work to be done with it. In the first place, the needles may be made more or less perfectly astatic and so freed more or less completely from the action of the earth's magnetism, and consequently more or less sensitive. Moreover, an astatic system seems to be preferable to one in which damping magnets are used, since it is freer from influence by local causes; though, if desirable for a coarser class of experiments, the considerable distance which separates the needles in this instrument, allows the use of a damping magnet with either of them. In the galvanometer now in use, the upper needle is the stronger, and gives sufficient directive tendency to the system, to bring the deflected needle back to zero quite promptly. In the experiments referred to below, the system made 25 oscillations per minute.

Secondly, the space beneath the mirror is sufficiently large to permit the use of a coil of any needed size. Since, therefore, the lower needle is entirely enclosed within the coil, the field of force within which it moves, may be made sensibly equal at all angles of deflection, as in the galvanometers of Sir William Thomson. Hence the indication of the instrument may be made quantitative, at least within certain limits. The circular coil too, has decided advantages over the flat coil, since the mass of wire being nearer to the needle, produces a more intense field. Were it desirable, a double coil, containing an astatic combination, could be placed below the mirror, the upper needle in that case serving only as an index. The instrument above described has a coil three inches in diameter and one inch thick; the diameter of the core being one inch. Since its resistance is only about a quarter of an ohm, it is intended for use with circuits of small resistance, such as thermo-currents and the like.

The results of a few experiments made with this new vertical-lantern galvanometer will illustrate the working of the instrument and will demonstrate its delicacy. The apparatus used was not constructed especially for the purpose, but was a part of the University collection.

Induction Currents.—1. The galvanometer was connected with a coil of covered copper wire, No. 11 of the American wire gauge, about ten centimeters long and six in diameter, having a resistance of 0·323 ohm. A small bar magnet 5 centimeters long and weighing six and a half grams, gave, when introduced into the coil, a deflection of 40°. On withdrawing the magnet, the needle moved 40° in the opposite direction.

2. A small coil, 20 centimeters long and 3·5 in diameter, made of No. 16 wire and having a resistance of 0·371 ohm,

through which the current of a Grenet battery exposing four square inches of zinc surface, was passing, was introduced into the center of a large wire coil, whose resistance was 0·295 ohm, connected with the galvanometer. The deflection produced was 20°. The same deflection was observed on making and breaking contact with the battery, the smaller coil remaining within the larger.

3. A coil of No. 14 copper wire, sixty centimeters in diameter, and containing about 40 turns, the resistance of which was 0·85 ohm, was connected with the galvanometer, and placed on the floor. Raising the south side six inches, caused a deflection of 4°. Placing the coil with its plane vertical, a movement of two centimeters to the right or left caused a deflection of 3°, and of twenty centimeters, of 10°. A rotation of 90° gave a deflection of 12° and one of 180°, of 24°. These deflections were of course due to currents generated by the earth's magnetism.

Thermo-currents.—4. Two pieces of No. 22 wire fifteen centimeters long were taken, the one of copper, the other of iron wire, and united at one end by silver solder. On connecting the other ends to the galvanometer, the heat of the hand caused a deflection of the needle of 20°.

5. A thermo-pile of 25 pairs, each of bismuth and antimony, was connected to the instrument. The heat from the hand placed at five centimeters distance caused a deflection of 8°.

6. Two cubes of boiling water acted differentially on the pile. At the distance of five centimeters the deflection was 20°; moving one to ten centimeters, the deflection was reduced to 5°.

Voltaic current.—7. A drop of water was placed on a zinc plate. While one of the connecting copper wires touched the zinc, the other was made to touch the water. The deflection was 16°.

The claim which is here made for the instrument, however, is rather for the general principle of its construction, than for the advantages possessed by the individual galvanometer above described, which was constructed at short notice, to meet an emergency. The comparatively small cost for which it may be fitted to the vertical lantern, the readiness with which it may be brought into use, the brilliantly illuminated circle of light which it gives upon the screen, with its graduated circle and needle, the great range of delicacy which may be given to the instrument by varying the coil and needles, so that all experimental requirements may be answered, and finally, the satisfactory character of its performance as a demonstration galvanometer, all combine to justify the record which is here made of it.

ART. XXXII.—*Brief Contributions to Zoology from the Museum of Yale College.* No. XXXV.—*Notice of the occurrence of another Gigantic Cephalopod* (*Architeuthis*) *on the coast of Newfoundland, in December*, 1874; by A. E. VERRILL.

IN an article published in this Journal, February and March, 1875,* I gave a summary of our information concerning twelve specimens of gigantic cephalopods that have been obtained in American waters during a few years past, together with a brief notice of the various specimens that have been described by European writers.†

I am now able to add some important information concerning an additional specimen which was cast ashore last winter at Grand Bank, Fortune Bay, Newfoundland. As in the case of several of the previous specimens, I am deeply indebted to the Rev. M. Harvey for information concerning this one, and also for the jaws and one of the large suckers of the tentacular arms, these being the only parts preserved. Although this specimen went ashore in December, Mr. Harvey did not hear of the event until March, owing to the unusual interruption of travel by the severity of the winter. He informs me that Mr. George Simms, Magistrate of Grand Bank, has stated in a letter to him that he examined the creature a few hours after it went ashore, but not before it had been mutilated by the removal of the tail by the fishermen, who finally cut it up as food for their numerous dogs; and that the long tentacular arms were 26 feet long and 16 inches in circumference (probably meaning at their broad terminal portion); the short arms were "one-third as long as the long ones, and about the same in circumference;" the back of the head or neck was 36 inches in circumference," (evidently meaning the head, behind the bases of the arms); the length of the body "from the junction to the tail" was 10 feet, (apparently meaning from the anterior edge of the mantle to the origin of the caudal fins). He thinks the tail, which had been removed, was about one-third as long as the body, but this is probably overestimated, judging from the Logie Bay specimen (No. 5 of my former papers), in which it

* This Journal, vol. ix, pp. 123, 177, Plates II–V. See also the American Naturalist, vol. ix, pp. 21, 78, January and February, 1875.

† In the "Journal de Zoologie," vol. iv, No. 2, p. 88, 1875, M. Paul Gervais has also given a summary of the gigantic cephalopods previously known, and has mentioned an additional species (*Architeuthis Mouchezi* Vélain), of which portions were brought to Paris by M. Vélain, from the Island of Saint Paul, where it was cast ashore. He also quotes the brief notice of the animal by M. Vélain (in Comptes rendus, t. lxxx, p. 1002, Seance du April 19, 1875). It is stated that this example belongs to the same group with *Ommastrephes*, and if so it will probably prove to be generically distinct from both of the Newfoundland species. M. Gervais does not refer, in any way, to the several American specimens described by the writer and others.

was about one-fifth, but it may have been cut off above its proper base. Allowing one-fifth also for the length of the head, the total length would be about 40 feet, the head and body together being about 14. The large sucker, in my possession, is one inch in diameter, across the denticulated rim, and in form and structure agrees closely with those previously described and figured by me from the tentacular arms of Nos. 4 and 5 (vol. ix, Plate IV, figs. 11, 12, 13).

The jaws are still attached together, in their natural position, by the cartilages.* They agree very closely in form with the large jaws of *Architeuthis princeps* V. (No. 10), figured on Plate V, vol. ix, but they are about one-tenth smaller. The upper jaw measures 111^{mm} in height (front to back); 88^{mm} from tip of beak to front edge of palatine laminæ; 20^{mm} from tip of beak to the base of the notch. The lower jaw measures 96^{mm} in total length; 80^{mm} from tip of beak to front edge of laminæ; 19^{mm} from tip to base of notch.

From the close agreement of these jaws with those of *A. princeps*, there can be very little doubt that they belong to that species; and if so the measurements given will be of great importance as affording additional knowledge of the approximate form and proportions of this, the largest known species.

NOTE.—In "The Zoologist," London, 2d Series, No. 118, p. 4526, July, 1875, there is an article entitled, "Notice of a gigantic Cephalopod (*Dinoteuthis proboscideus*), which was stranded at Dingle, in Kerry, two hundred years ago. By A. G. More, F.L.S." The article is chiefly a reprint of the rude popular accounts written at the time of the capture, and upon these alone Mr. More attempts to found a new genus and species. The one character which he relies upon as of generic value, is the power of projecting the beak in the form of a proboscis. But he apparently does not know that this is habitually done by the various common species of *Ommastrephes*, *Loligo*, etc., and perhaps by all ten-armed cephalopods. There is no reason to suppose, from the published accounts, that this specimen differed in any way from the *Architeuthis monachus*. It was described as 19 feet in total length, the long arms having been mutilated, the part remaining was 11 feet long, and as thick as a man's arm; the short arms varied from 6 to 8 feet in length, and were as thick as a man's leg, and had two rows of large serrated suckers; the proboscis (buccal mass with beak) was the "size of a man's fist;" the beak was "like an eagle's but broader." The whole animal was said to have been as large as a large horse. The measurements given indicate a specimen smaller than several of the American examples, and but little, if any, larger than our No. 5, from Logie Bay.

In the August number of the "Annals and Magazine of Natural History," vol. xvi, p. 123, the same writer has briefly described the beak, and portions of the tentacles and arms of another specimen taken off Boffin Island, on the west coast of Ireland, last April. The tentacular arms are said to have been 30 feet long; the expanded portion 2 feet 9 inches; the large central suckers nearly 1 inch in diameter; those of the outer rows 5 of an inch; one short arm is said to have been 8 feet long, and 15 inches in circumference at the base, when fresh.

Mr. More believes this to be distinct from the Newfoundland species and refers it to *A. dux*, but his description agrees closely with the corresponding parts of *A. monachus* (No. 5) described by me. He appears to be ignorant of my articles on the subject, published in this Journal.

* These will be figured in an article on the gigantic cephalopods, now in preparation for the Transactions of the Connecticut Academy of Sciences.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Hypochloric oxide and Euchlorin.*—Pebal has made an xtended investigation into the properties of hypochloric oxide nd euchlorin. These substances were first investigated by Davy, he former in 1815, the latter in 1811; but owing to the difficulty nd danger of the operation, their accurate composition has emained unknown. The substance experimented on was obtained ither by the action of hydrochloric acid diluted with an equal olume of water upon potassium chlorate, or preferably by the ction of dilute sulphuric acid upon a mixture of 20 parts potassium chlorate and 48 parts sodium chloride. The acid was conained in a flask with a lateral tubulure, connected with a similar ask containing the mixture. By raising or lowering the former ask, the access of the acid to the latter flask could be regulated. he gas as evolved was first washed, then dried by a calcium hloride tube, then passed into a flask immersed in a freezing ixture, connected with a tube closed by cocks at both ends alled an explosion tube). The composition of the gas in this be was determined, either (1) by connecting the tube after xplosion with a similar tube standing over a saturated salt lution, thus measuring the expansion, and then estimating the hlorine and oxygen by absorption of the former; (2) by passing e exploded gases through potassium iodide solution and titering e iodine set free; or (3) by calculating the composition from the eight of the known volume of the mixture. The author concludes: 1st, that the composition of hypochloric oxide, calculated y Davy and Gay Lussac from their experiments, is correct; his xperiments affording for its molecular weight 67·29 and its rmula ClO_2; 2d, that the boiling point of the liquid oxide is bout 9° C., and not 20° nor 32° as has been asserted; 3d, that uchlorin is a mixture of hypochloric oxide and free chlorine, the roportions of the constituents varying with the mode of preparaion; and 4th, that Millon's statement of the existence of a comound Cl_6O_{13} rests on mistaken conclusions.—*Liebig's Annalen*, lxxvii, 1, May, 1875. G. F. B.

2. *On the presence of Sulphuric oxide in the Gaseous products f combustion of Pyrite.*—Schurer Kestner finds that the abunlant white fumes which accompany the sulphurous oxide which evolved in the combustion of pyrite, are not sulphuric acid as ras supposed, but consist of sulphuric oxide. To ascertain how his substance was produced, he made a series of experiments. In he first, he passed a slow current of sulphurous oxide through a latinum tube forty centimeters long, heated to a temperature but ttle inferior to that of the pyrites furnace; but with no result. he SO_3 does not therefore come from dissociation of SO_2. In a econd experiment, the sulphurous oxide was mixed with twice s volume of air; but the issuing gases did not render turbid a

solution of barium chloride. Finally, the same mixture of gases was passed through the heated tube which was now filled with ferric oxide obtained as a residue in the combustion of the pyrite. Abundant white fumes were evolved which gave a precipitate of barium sulphate. The amount of the sulphuric oxide formed does not exceed two or three per cent of the sulphurous oxide. Its production accounts for the loss of oxygen observed in the sulphuric acid manufacture.—*Bull. Soc. Chim.*, II, xxiii, 437, May, 1875. G. F. B.

3. *On Calcium Hypochlorite from Bleaching Powder.*—KINGZETT has thrown some light upon the chemical constitution of bleaching powder, a subject upon which very much discussion has recently been had, by obtaining from it calcium hypochlorite. The freezing of a saturated solution of bleaching powder, which yielded needle-shaped crystals called his attention to the matter; he repeated the experiment and isolated the crystals. They dissolved in water, depositing calcium carbonate, the solution evolved chlorine with acids and contained calcium. Another portion of bleaching powder solution evaporated over sulphuric acid and potash in a vacuum, gave a dense crystalline mass, insoluble in alcohol, and having oxidizing and bleaching properties. It smelled of hypochlorous acid, contained chlorine and calcium and evolved free chlorine with hydrochloric acid. A second solution similarly treated yielded 2 grams of a first crop of crystals which gave on analysis 18·54 per cent Ca and 30·20 Cl; the formula $CaCl_2O_2$, $(H_2O)_4$ requires 18·60 Ca and 33·02 Cl. The second crop of crystals, partially dried, as well as freshly prepared crystals gave calcium, chlorine and oxygen in very nearly the atomic ratios 1 : 2 : 2, which are those required by calcium hypochlorite. Hence Kingzett regards Odling's view of the constitution of bleaching powder $Ca\left\{\begin{matrix}Cl\\OCl\end{matrix}\right.$, as the most probable, but believes that it is decomposed by water into $CaCl_2O_2$ and $CaCl_2$.—*J. Chem. Soc.*, II, 404, May, 1875. G. F. B.

4. *Occurrence of Bromoform in Commercial Bromine.*—In titering, by means of potassium iodide, a solution of bromine in water, REYMANN observed that the result obtained was too low and that the liquid possessed a peculiar odor recalling that of chloroform. Further investigation showed the bromine to be mixed with at least 10 per cent of a substance boiling between 80° and 165°, the principal part of which consists of bromoform. It is readily detected by the influence it has in lessening the solubility of bromine in water as well as by its odor, which is most readily perceived when the bromine is agitated with a solution of potassium iodide, and the whole decolorized by sodium thiosulphate.—*Ber. Berl. Chem. Ges.*, viii, 792, June, 1875. G. F. B.

5. *On the use of Spectrum Analysis in titrition.*—VIERORDT has proposed to use his exceedingly ingenious quantitative method of spectrum analysis in titrition. In a word, this method measures the intensity of any colored light by the quantity of white light

necessary to extinguish it. To apply it to volumetric analysis, as for example to the determination of dextrose by Fehling's solution, he would proceed as follows: Add to a measured volume of Fehling's copper solution a measured volume of the sugar solution to be tested, which must contain an amount of sugar less than is required to reduce the whole of the copper. After the reaction is over, therefore, the liquid will still be blue. By the spectro-analytic method, using that portion of the spectrum where the light is most strongly absorbed, the quantity of the still unreduced copper is determined; and of course, its sugar-equivalent. Subtracting from the sugar-equivalent of the copper solution originally used, that now found, the difference is that of the sugar in the solution. The advantages claimed for the method are: 1st, It does not depend for its accuracy upon a definite, quantitatively exact point in the reaction; hence the continual testing and the use of control-experiments to fix this point, are avoided. Moreover, the time required for its application is shorter. 2d, The necessity for great care in the constancy of the test-liquid is avoided. The extinction coefficient is readily and easily determined at the time of use. 3d, The small volume of the liquid (about two cubic centimeters) which is required. 4th, It admits perfectly of control-experiments, since the volume-relations of the liquids and the degree of their dilution may be varied within wide limits. 5th, The result is not affected by the presence of coloring matter. And 6th, It does not require, like the ordinary method, a long practice with it in order to obtain exact results. Results of the use of the method are given which are closely accordant and quite satisfactory.—*Liebig's Annalen*, clxxvii, 31, May, 1875. G. F. B.

6. *Fluorene and fluorene Alcohol.*—BARBIER, having shown that fluorene—a hydrocarbon first obtained by Berthelot from coal tar—$C_{12}H_8$, CH_2, may be transformed by oxidation into diphenylene-carbonyl $C_{12}H_8$, CO, has now succeeded in producing a series of compounds from it, by taking advantage of the peculiar properties of the carbonyls as first pointed out by Berthelot. When sodium amalgam reacts on diphenylene carbonyl in alcoholic solution, a substance is produced which, after crystallization from boiling benzol, appears as hard white hexagonal plates, having the composition $C_{12}H_8$, CHOH. It is fluorene alcohol. The reaction is

$$C_{12}H_8(CO)+H_2=C_{12}H_8(CH_2O)=C_{12}H_8(CHOH).$$

It melts at 153°, and is oxidized by chromic acid to diphenylene carbonyl again. When heated for some time above its fusing point, it loses water and yields fluorene ether, which melts at about 290°. It is formed also when the alcohol is heated to 150° or 160° with acetic oxide. Analysis gives its composition as $(C_{12}H_8, CH)_2O$. When the alcohol is heated with acetic oxide to 100° for eight hours, an aceto-fluorene ether $(C_{12}H_8, CH)(C_2H_3O)O$ is produced, in rhomboidal plates fusible at 75°. Fluorene alcohol is the first alcohol discovered which loses water

by heat alone and forms an ether. It plays the part of an incomplete pseudo-alcohol.—*C. R.*, lxxx, 1396, June, 1875. G. F. B.

7. *On Pararabin, a new Carbohydrate.*—REICHARDT has prepared both from the tissue of beets and of carrots, a new carbohydrate, which on account of its close resemblance to Scheibler's arabinic acid, he calls *pararabin.* The root is rasped, the pulp pressed out, treated with water and alcohol to remove everything soluble, digested for several hours with a one per cent solution of hydrochloric acid, heated to boiling and the liquid strained off. Alcohol throws down a gelatinous precipitate, which after washing with alcohol and drying, forms a friable white powder, swelling up in water and dissolving on the addition of an acid when heated. Alkalies precipitate it again, and it gives no sugar by the action of sulphuric acid. Its formula is $C_{12}H_{22}O_{11}$. It differs from arabinic acid by its neutral reaction and its chemical indifference; by its yielding no sugar; by its solubility in acids and precipitation by alkalies instead of the reverse. If, however, it is acted on for a long time by an alkali, or if it be warmed in contact with it, it is converted into arabinic acid. Quantitative experiments showed that 38·5 per cent of the beet pulp was arabinic acid, 54·0 per cent pararabin, and 7·5 per cent cellulose. —*Ber. Berl. Chem. Ges.*, viii, 807, June, 1875. G. F. B.

8. *Friction of Rarefied Gases.*—A. KUNDT and E. WARBURG have investigated some results of the kinetic theory of gases when the pressure is exceedingly small. This theory presupposes that the mean length of path of the molecules is a quantity that may be neglected in comparison with the linear dimensions of the space filled with the gas. But as this path is inversely as the density, this is equivalent to saying, that the density in a given space must not be too little. It appears that the sliding coefficient for a gas and a solid partition has sensibly a determined value dependent on the nature of the gas, so long as the latter is present in layers thicker than fourteen times the mean length of path; and it is inversely proportional to the pressure. The absolute value of the sliding coefficient is obtained by admitting that the gas molecules are reflected from the partition with its velocity of translation, to 1·4 ($\frac{1}{2}l$),—consequently for air, for which at 760 mms. pressure $l=\cdot000083$ mms., according to Stefan, to $\cdot000058\,\frac{760}{p}$, p being the pressure in mms. of mercury. The present experiment gives the coefficient about twice as great, or ·0001. From this we may conclude that on the collision of the molecules with the partition the velocities of translation of the two are not perfectly balanced. The present experiments are conducted according to Maxwell's method. The logarithmic decrement of the torsional vibrations executed by a glass disk between two fixed disks near it was measured. The diameter of the moving disk was 159 mms., its weight 61·9 grms., and it was held by a bifilar suspension of two fine silver wires ·063 mms. in diameter. This made the disturbing damping movements so slight that they might

be neglected; with the smallest decrements measured, they only amounted to a little over one per cent, and with nearly all the measurements employed for calculations much less than one per cent, of the total value observed. A substantial simplification of the apparatus employed was thus obtained, one vibrating disk being sufficient. With pressures of the air varying from 750 to 380 mms., the absolute coefficient of friction of air was found to be ·000189. Maxwell found the value ·000198, Meyer by Maxwell's method ·000197, Meyer from transpiration experiments found ·000182 and Puluj ·000185. Calling the coefficient of air 1, that of H was ·488 and of CO_2 ·806, while Graham's transpiration experiments gave ·4855 and ·807. Pure aqueous vapor at 21° C. and 16 mms. pressure gave ·526. To test the theory at low pressures the chief difficulty consisted in filling the space with pure gases. Nothing could be done with caoutchouc connections, which were, therefore, replaced by glass joints, while to secure flexibility and security against fracture by expansion, thick, wide, elastic glass tubes were inserted, bent in three directions at right angles. Exhaustion was produced by a Geissler mercury pump. With pressures from 380 mms. to 1·5 mms. the logarithmic decrement altered from ·0425 to ·0405 in the case of air, and from ·0341 to ·0331 in the case of hydrogen. In carrying the exhaustion still further, great difficulty was experienced in removing the last traces of aqueous vapor. In four cases the logarithmic decrement had the values, ·0180, ·0140, ·0119 and ·0220. In the first the vacuum was obtained directly with the pump, in the second the little gas bubble was allowed to pass from the receiver into a vacuum, and in the third this was continued until nothing passed out even then. In the last case the third vacuum was allowed to stand over night. With a pressure of 760 mms. the value of the decrement was ·0387.—*Phil. Mag.*, 1, 53; *Proc. Roy. Pruss. Acad.*, 1875, p. 160. E. C. P.

9. *Conductibility of Heat by Gases.*—A. KUNDT and E. WARBURG have studied also the flow of heat through gases at very low pressures. As in the case of friction, the law must change when the density becomes so small that the mean length of path becomes appreciable. The difference in temperature here corresponds to the difference in velocity in the case of friction. The experiment consisted in the measurement of the rapidity of cooling of thermometers of various forms in glass cases of different shapes at 0°. At high pressures the effects are masked by air currents, but with low pressures this disturbance disappears. Thus with a spherical thermometer the velocity was independent of the pressure when the latter was contained between 10 mms. and 1 mm., and affords an accurate means of calculating the coefficient of heat conduction. Calling that of hydrogen 1, that of air was found to be ·137, and that of CO^2, ·082 against ·141 and ·103 calculated by Maxwell. The time of cooling of a thermometer in a vacuum diminishes if left to itself, in one experiment changing in twelve hours from 351 to 307 seconds. This change is probably

due to exceedingly minute traces of aqueous vapor from the plug of the stop-cock. The quantity of ponderable matter is so small, and the ease of measuring the velocity of cooling such, that it seems to offer an extremely good test for the quality of a vacuum. In an experiment, under 760 mms. pressure, the time was 225 seconds, under 1·3 mms. 364, and continually increasing the exhaustion the times 664, 555, 602 and 712·5 seconds were obtained. The last number was the result of drying the apparatus in an oil bath at 200° C., and shutting it off at that temperature. To prove that we thus obtain an actual vacuum with regard to heat conduction, a thermometer was manufactured which by slips of glass could be put into two different envelopes. With medium pressures the times of cooling were nearly as one to two, but with the most perfect exhaustion the times became almost identical. Thus at 760 mms. the times were 171 and 114, at 168 mms. 234 and 114, at 9·5 mms. 270 and 116, at 0·5, 280 and 154, and with the last vacuum 576 and 576. Replacing the air by hydrogen, gave 588 and 578, and with carbonic acid 586 and 578. In the experiments of Dulong and Petit, their most perfect vacuum must still have possessed, according to these experiments, its full heat-conducting power. In one series of their experiments the ratio of the quantities of heat carried over by radiation and conduction was 6, and in the other 2·5. Their experiments, therefore, cannot be looked upon as rigorously demonstrating the law founded upon them, the significance of which is, moreover, according to the authors themselves, detracted from by the dependence of the specific heat of mercury on the temperature.—*Phil. Mag.*, l, 58; *Proc. Roy. Pruss. Acad.*, 1875, p. 160. E. C. P.

10. *Emissive Power of Leaves.*—M. MAQUENNE on comparing the quantity of water evaporated by a cultivated soil during vegetation with that furnished by the rain, finds in general an excess in favor of the former. May not this excess be caused by the dew deposition at night on the plants? When the dew is measured by a pluviometer the results are much too small. The leaves condense far more than surrounding bodies, and their temperature may fall six or eight degrees below the air, showing that their emissive power is much greater than that of the metal surfaces of the pluviometer.

To determine the emissive power of leaves, a Leslie cube was employed; one of its faces was blackened, another covered with leaves, and the two surfaces turned successively to the pile. The temperature of the water did not exceed 40°, to avoid injuring the leaves. The deflections were measured by a mirror and scale, and a twentieth of a degree was easily observed. On trying several kinds of leaves it appeared that their emissive power did not differ greatly, was the same on both sides, and had an average value of 94, that of lampblack being 100.

To measure the absorbent power, a thermopile was formed of a thin sheet of copper riveted to a steel spring. One face was covered with lampblack, the other with the leaf to be examined.

Exposing the two surfaces in turn to the radiation of a metallic blackened box heated by steam, and waiting until the galvanometer needle came to rest, the ratio of the deviations gave the absorbent power of the leaf. From the results it appeared that the absorbent power was sensibly equal to the emissive power, and consequently the amount of dew deposited on plants should be determined by pluviometers painted black.—*Comptes Rendus*, lxxx, 1357. E. C. P.

11. *Velocity of Magnetization.*—M. DEPREZ, in pursuing his researches on electro-magnets and their application to the registration of very rapid phenomena, the first results of which have already been communicated to the Academy, has been led to investigate what was the effect of the nature of the iron of the electro-magnet upon the duration of the phases of magnetization and demagnetization. For this purpose he employed a register in which the pieces of iron constituting the electro-magnet are removable, the bobbins, armature, style, etc., remaining the same, so as to make evident the influence of the metal of the electro-magnet. To measure the duration of the phases he used the method indicated in his communication on electric chronographs. The metallic portion of the elecro-magnets consisted of cores two mms. in diameter and thirteen mms. in length. The coils contained fourteen meters of wire two mms. in diameter. The battery consisted of one Bunsen cell modified by Delaurier. The varieties of iron tried were the ordinary iron of commerce, the soft iron used specially for telegraphs, malleable cast iron, cast steel stretched and chilled, and gray cast iron. The results were quite unexpected, for all but the last kind of iron gave nearly the same period for magnetization and demagnetization. The first of these was about ·0015, and the second ·00025. The gray cast iron gave still better results, the time of magnetization was reduced to about $\frac{1}{1000}$ of a second. It would seem, therefore, to be the metal which would permit the greatest possible rapidity in the transmission of signals. With his registers, perfectly distinct signals can be obtained at intervals of $\frac{1}{350}$ of a second, or with gray cast iron at intervals of $\frac{1}{500}$ of a second. With a series of signals at regular intervals much greater rapidity is attainable. The superiority of cast iron appears to depend on its molecular texture and not on the quantity of carbon which it contains. It is probable that with soft iron, cast but not forged, still better results will be obtained. The above durations do not include the time employed by the style in traversing its trajectory; it is by adding this to the durations of magnetization and demagnetization the $\frac{1}{350}$ and $\frac{1}{300}$ of a second, according to the case, is found for the total duration of the signal. It therefore includes the demagnetization, the time of fall of the style, the magnetization, and the return of the style to its initial position. These are, moreover, the numbers when only one cell is employed; by increasing the current the rapidity of action is also increased.—*Comptes Rendus*, lxxx, 1353; *Phil. Mag.*, l, 79. E. C. P.

12. *The "Challenger's" Crucial Test of the Wind and Gravitation Theories of the Oceanic Circulation;* by JAMES CROLL. (From pp. 220—225 of Prof. Croll's work on "Climate and Time.")—It has been shown in former chapters that all the facts which have been adduced in support of the gravitation theory are equally well explained by the wind theory. We may now consider a class of facts which do not appear to harmonize with both theories. The recent investigations of the *Challenger* Expedition into the thermal state of the ocean reveal a condition of things which appears to me utterly irreconcilable with the gravitation theory.

It is a condition absolutely essential to the gravitation theory that the surface of the ocean should be highest in equatorial regions and slope downward to either pole. Were water absolutely frictionless, an incline, however small, would be sufficient to produce a surface-flow from the equator to the poles; but to induce such an effect some slope there must be, or gravitation could exercise no power in drawing the surface-water polewards.

The researches of the *Challenger* Expedition bring to light the striking and important fact that the general surface of the North Atlantic in order to produce equilibrium must stand at a higher level than at the equator. In other words, the surface of the Atlantic is lowest at the equator, and rises with a gentle slope to well nigh the latitude of England. If this be the case, then it is mechanically impossible that, as far as the North Atlantic is concerned, there can be any such general movement as Dr. Carpenter believes. Gravitation can no more cause the surface-water of the Atlantic to flow toward the arctic regions than it can compel the waters of the Gulf of Mexico up the Mississippi into the Missouri. The impossibility is equally great in both cases.

In order to prove what has been stated, let us take a section of the mid-Atlantic, north and south, across the equator; and, to give the gravitation theory every advantage, let us select that particular section adopted by Dr. Carpenter as the one of all others most favorable to his theory, viz: Section marked No. VIII in his memoir lately read before the Royal Geographical Society.*

The fact that the polar cold water comes so near the surface at the equator is regarded by Dr. Carpenter as evidence in favor of the gravitation theory. On first looking at Dr. Carpenter's section it forcibly struck me that if it was accurately drawn, the ocean to be in equilibrium would require to stand at a higher level in the North Atlantic than at the equator. In order, therefore, to determine whether this is the case or not I asked the hydrographer of the Admiralty to favor me with the temperature soundings indicated in the section, a favor which was most obligingly granted. The following are the temperature soundings at the three stations

* Proc. Roy. Geog. Soc., vol. xviii, p. 362. A more advantageous section might have been chosen, but this will suffice. The section referred to is shown in Plate III. The peculiarity of this section, as will be observed, is the thinness of the warm strata at the equator, as compared with that of the heated water in the North Atlantic.

A, B, and C. The temperature of C is the mean of six soundings taken along near the equator:—

Depth in Fathoms.	A Lat. 37° 54′ N. Long. 41° 44′ W. Temperature.	B Lat. 23° 10′ N. Long. 38° 42′ W. Temperature.	C Mean of six temperature soundings near equator. Depth in fathoms.	C Temperature.
Surface.	70°·0	72°·0	Surface.	77°·9
100	63·5	67·0	10	77·2
200	60·6	57·6	20	77·1
300	60·0	52·5	30	76·9
400	54·8	47·7	40	71·7
500	46·7	43·7	50	64·0
600	41·6	41·7	60	60·4
700	40·6	40·6	70	59·4
800	38·1	39·4	80	58·0
900	37·8	39·2	90	58·0
1000	37·9	38·3	100	55·6
1100	37·1	38·0	150	51·0
1200	37·1	37·6	200	46·6
1300	37·2	36·7	300	42·2
1400	37·1	36·9	400	40·3
1500	...	36·7	500	38·9
2700	35·2	...	600	39·2
2720	...	35·4	700	39·0
			800	39·1
			900	38·2
			1000	36·9
			1100	37·6
			1200	36·7
			1300	35·8
			1400	36·4
			1500	36·1
			Bottom.	34·7

On computing the extent to which the three columns A, B, and C, are each expanded by heat according to Muncke's table of the expansion of sea water for every degree Fahrenheit, I found that column B, in order to be in equilibrium with C (the equatorial column), would require to have its surface standing fully 2 feet 6 inches above the level of column C, and column A fully 3 feet 6 inches above that column. In short, it is evident that there must be a gradual rise from the equator to latitude 38° N. of 3½ feet. Any one can verify the accuracy of these results by making the necessary computations for himself.*

I may observe that, had column C extended to the same depth as columns A and B, the difference of level would be considerably greater, for column C requires to balance only that portion of

* The temperature of column C in Dr. Carpenter's section is somewhat less than that given in the foregoing table; so that, according to that section, the difference of level between column C and columns A and B would be greater than my estimate.

columns A and B which lies above the level of its base. Suppose a depth of ocean equal to that of column C to extend to the north pole, and the polar water to have a uniform temperature of 32° from the surface to the bottom, then, in order to produce equilibrium, the surface of the ocean at the equator would require to be 4 feet 6 inches above that at the pole. But the surface of the ocean at B would be 7 feet, and at A 8 feet, above the poles. Gravitation never could have caused the ocean to assume this form. It is impossible that this immense mass of warm water, extending to such a depth in the North Atlantic, could have been brought from equatorial regions by means of gravitation. And, even if we suppose this accumulation of warm water can be accounted for by some other means, still its presence precludes the possibility of any such surface-flow as that advocated by Dr. Carpenter. For so long as the North Atlantic stands 3½ feet above the level of the equator, gravitation can never move the equatorial waters poleward.

There is another feature of this section irreconcilable with the gravitation theory. It will be observed that the accumulation of warm water is all in the North Atlantic, and that there is little or none in the south. But according to the gravitation theory it ought to have been the reverse. For owing to the unrestricted communication between the equatorial and antarctic regions, the general flow of water toward the south pole is, according to that theory, supposed to be greater than toward the north, and consequently the quantity of warm equatorial water in the South Atlantic ought also to be greater. Dr. Carpenter himself seems to be aware of this difficulty besetting the theory, and meets it by stating that "the upper stratum of the North Atlantic is not nearly as much cooled down by its limited polar underflow, as that of the South Atlantic is by the vast movement of antarctic water which is constantly taking place toward the equator." But this "vast movement of antarctic water" necessarily implies a vast counter-movement of warm surface-water. So that if there is more polar water in the South Atlantic to produce the cooling effect, there should likewise be more warm water to be cooled.

According to the wind theory of oceanic circulation the explanation of the whole phenomena is simple and obvious. It has already been shown that owing to the fact that the S. E. trades are stronger than the N. E., and blow constantly over upon the northern hemisphere, the warm surface-water of the South Atlantic is drifted across the equator. It is then carried by the equatorial current into the Gulf of Mexico, and afterward of course forms a part of the Gulf-stream.

The North Atlantic, on the other hand, not only does not lose its surface heat like the equatorial and South Atlantic, but it receives from the Gulf-stream in the form of warm water an amount of heat, as we have seen, equal to one-fourth of all the heat which it receives from the sun. The reason why the warm surface strata are so much thicker on the North Atlantic than on the equatorial

egions is perfectly obvious. The surface-water at the equator is wept into the Gulf of Mexico by the trade winds and the equatoial current, as rapidly as it is heated by the sun, so that it has ot time to gather to any great depth. But all this warm water s carried by the Gulf-stream into the North Atlantic, where it ccumulates. That this great depth of warm water in the North Atlantic, represented in the section, is derived from the Gulftream, and not from a direct flow from the equator due to gravi- ation, is further evident from the fact that temperature sounding A in latitude 38° N. is made through that immense body of warm vater, upwards of 300 fathoms thick, extending from Bermuda to ear the Azores, discovered by the *Challenger* Expedition, and ustly regarded by Captain Nares as an offshoot of the Gulftream. This, in Captain Nares's Report, is No. 8 "temperature ounding," between Bermuda and the Azores; sounding B is No. "temperature curve," between Teneriffe and St. Thomas.

There is an additional reason to the one already stated why the urface temperature of the South Atlantic should be so much elow that of the North. It is perfectly true that whatever mount of water is transferred from the southern hemisphere to he northern must be compensated by an equal amount from the orthern to the southern hemisphere, nevertheless the warm water which is carried off the South Atlantic by the winds is not lirectly compensated by water from the north, but by that cold ntarctic current whose existence is so well known to mariners rom the immense masses of ice which it brings from the Southrn Ocean.

Thermal Condition of the Southern Ocean.—The thermal condiion of the Southern Ocean, as ascertained by the *Challenger* Expedition, appears to me to be also irreconcilable with the gravitaion theory. Between the parallels of latitude 65° 42′ S. and 50° ′ S., the ocean, with the exception of a thin stratum at the surace heated by the sun's rays, was found, down to the depth of bout 200 fathoms, to be several degrees colder than the water inderneath.* The cold upper stratum is evidently an antarctic urrent, and the warm underlying water an equatorial under curent. But, according to the gravitation theory, the colder water hould be underneath.

The very fact of a mass of water, 200 fathoms deep and extending over fifteen degrees of latitude, remaining above water of three or four degrees higher temperature, shows how little influence difference of temperature has in producing motion. If it had the potency which some attribute to it, one would suppose that this cold stratum should sink down and displace the warm water underneath. If difference of density is sufficient to move the water horizontally, surely it must be more than sufficient to cause it to sink vertically.

13. *On the artificial imitation of magnetipolar native platinum;* by M. DAUBRÉE.—M. Daubrée, in a memoir read before the

* Captain Nares's Report, July 30, 1874.

French Academy of Sciences in March, 1875, and published in vol. lxxx, of the Comptes Rendus, gives the results of a series of experiments on platinum, in which he succeeded in imitating entirely the platinum having magnetic polarity, by combining iron with the metal in fusion.

Daubrée observes, in his introductory remarks, that in washing the auriferous sands of the Ural, some gold is left in the residue associated with ferruginous grains. To separate the latter a strong native magnet is first used; and after this takes up no more, a magnet of native platinum—as Von Kokscharow first made known in 1866 — will remove ferruginous grains of notable quantity, as if it were a stronger magnet than the native magnetite magnets. The presence of 12 to 19 per cent of iron in this variety of platinum has long been known, it having been first examined by Berzelius; and Breithaupt made the variety a distinct species, calling it "*Eisenplatin*." Gustaf Rose, thinking that the iron present was insufficient to account for the magnetic property, supposed that iridium contributed to it.

In a piece of this iron-platinum weighing twelve grams, received from the Ural, Daubrée found three axes and six poles.

Before proceeding with his experiments for reproducing this magnetipolar platinum, Daubrée sought to ascertain what effect fusion would have upon the ore. On fusing it there were some sparks thrown off, due apparently to the combustion of a little iron, and a dull surface film was formed. When cooled again, after fusion for about one minute, the magnetic property was somewhat weakened and polarity was lost, evidently owing to the loss of iron.

In his experiments, 24 grams of platinum were fused with 6 grams of very soft iron wire, the iron being twisted into a cord and added when the platinum was in full fusion. Immediately on the introduction of the iron it was instantly dissolved, giving out, as in the other case, some sparks, and making a surface scoria, although the substance remained in fusion only a fraction of a minute. The button, when taken out from the crucible, proved to have very marked magnetic polarity; and when it was afterward broken to fragments by a hammer, in an attempt to beat it into a bar, each fragment was equally magnetipolar. A very small bar was afterward cast; this had energetic poles of opposite polarity, which remained after the crust of scoria had been removed. These poles were four in number, two at each extremity of the bar. The hardness of the alloy was a little less than that of apatite. An analysis of the product obtained in the first trial, made at the Ecole des Mines, gave iron 16·87, platinum 83·05= 99·92. Its specific gravity was 15·66. The specific gravity of the second alloy was 15·70, showing that in composition it was very like the first. Both are, therefore, closely similar in composition to the native magnetipolar platinum.

Others alloys were made with 50 to 75 per cent of iron; but these had no polarity. An alloy with 21·6 per cent of iron, made

3erthier and preserved in the laboratory of the Ecole des es, although imperfectly fused, was magnetipolar. On the r hand, alloys containing but a feeble proportion of iron were d to be not magnetipolar.

he polarity of the alloy obtained by fusion existed in the s on cooling, and was not imparted by touch. It seemed t natural to refer this polarity to the inductive influence of the h's magnetism. To ascertain the fact on this point a little inum bar was placed, while still in fusion, exactly in the plane he magnetic meridian. After solidifying, it was put, while very hot, parallel to the dipping needle. It was then found the bar had two energetic poles, and that the end toward the netic north repulsed strongly the north end of a magnetic lle. Afterward, on fusing again and reversing the position, polarity was reversed.

hese decisive experiments of Daubrée illustrate, he says, like e of M. Sidot with magnetic pyrites, the importance of the h's general action in determining the polarity of different netic minerals and rocks at the time when they are formed.

. *How to teach Chemistry.*—Dr. EDWARD FRANKLAND'S six ıres delivered at the Royal College of Chemistry in June, , have been summarised and edited by GEORGE CHALOUER, S.; the Lectures on Chemistry at the Brisbeck Institution in nall 12mo volume of only 83 pages, republished by Messrs. lsay and Blakiston of Philadelphia in a neat form, and abun- ly illustrated, chiefly by engravings from Bloxam's Text- c of Chemistry.—This is a truly valuable contribution to the ns of instruction. The six lectures discuss in synoptic man- (I.) Natural Forces, Chemical Force, Chemical Action, mination of Water, with Experiments 1 to 12. (II.) Hydro- Oxygen, Exact Composition of Water (Experiments 13 to 17 26 to 30). (III.) Properties of Water, Ozone, Hydroxyl, mination of Hydrochloric Acid, Chlorine, study of Hydro- ric Acid (Experiments 18 to 25 and 31 to 38). (IV.) Oxy- pounds of Chlorine, Boron and its Oxyd, Carbon and its ds, Nitrogen, Igniting points (Experiments 39-64). (V.) compounds of Nitrogen, Ammonia (Experiments 65 to 88.)) Doctrine of Atomicity, Laws of Condensation in volume, lacement of Hydrogen with its Compounds, Sulphur, Sulphu- d Hydrogen, Oxyds of Sulphur, Sulphuric acid and its ufacture, Hyposulphurous acid, Conclusion (Experiments 89 09). In an Appendix is given (I) Syllabus of Elementary rse in Organic Chemistry. (II.) Extract from a Report by Frankland, List of Experiments. (III.) List of Apparatus teaching Elementary Chemistry, Elementary Stage. (IV.) of Chemical Apparatus for Special Important Illustration.

is little manual will be found an invaluable adjunct to the ıre room and is of special importance to the teacher who s trustworthy and novel illustrations for guidance in impart- knowledge of chemical principles and methods to his classes. hand of the master is seen on every page.

II. Geology and Natural History.

1. *Cotemporaneous formation, in the thermal waters at Bourbonne-les-Bains, of different Mineral Species.* — M. Daubrée, (C. R. Feb. and March, 1875, t. lxxx) describes the following minerals as of recent formation from these thermal waters: *tetrahedrite* (gray antimonial copper), *chalcopyrite* (copper pyrites), *bornite* (variegated copper or phillipsite), *chalcocite* (sulphide of copper), *pyrite*, *galenite*, *anglesite*, *calcite* and *chabazite*. By pumping, the bottom of an old well, at Bourbonne-les-Bains, called the Roman well, was laid bare. The material was a black argillaceous earth containing bits of wood, nuts, etc., and then, at a lower level, thousands of roman coins of bronze, silver and gold, besides statuettes, rings and pins. Besides this archeological discovery, there was found, still lower down, a bed of pebbles partly cemented by substances having a metallic lustre and neatly crystallized. A collection of the specimens were sent by M. Trautmann, Engineer in Chief of the Mines, to the Minister of Public Works, who transmitted them to Prof. Daubrée. Daubrée found abundant evidence that the above-mentioned ores, present in the specimens, were all formed out of the coins through the action of the warm waters. The different copper ores were all in good crystals—chalcocite in twinned hexagonal tables, chalcopyrite in octahedrons, bornite in octahedrons and cubes, tetrahedrite in tetrahedrons—besides being also in crusts.

The temperature of the waters is near 60° C. The substances the waters hold in solution are chiefly chlorides and sulphates of the alkalies, and of lime and magnesia, as well as bromides and carbonates of iron and lime, an alkaline silicate, and traces of arsenic and manganese, with no sulphides. The total weight of the residue on evaporation is 7 to 8 grams per litre. Daubrée observes that the sulphides would have been formed through the reduction of the sulphates by the organic matter present. It is remarkable, as he says, that sulphides so unlike should have been crystallized together under circumstances apparently the same. The antimony is referred by him to the coins, some of which probably contained it. The silver coins are less corroded than the bronze and hence the absence of silver products.

The chabazite was formed in connection with a cement of fragments of brick and lime, in a Roman gallery through which run the hot water. The cavities in the brick, caused by the heat, are sometimes lined with colorless rhombohedral crystals, nearly cubic in form, which have the characters of chabazite. In the lime, small crystals occur of a right rectangular form which have not yet been determined with certainty, but which resemble much those of lime-harmotome found under similar circumstances at Plombières.

Such facts teach us, says Daubrée, how important has been the agency of the water imbibed by, or traversing, rocks, in all parts

ıe earth's crust, especially in regions where terrestrial heat is a ; elevated, giving the moisture special energy in effecting ɜral changes.

Man of the Quaternary; by JOHN EVANS. (From the Ad- ɜ of Mr. Evans, President of the Geological Society of Lon- Feb. 19, 1875.)—Of the great geological changes in the ıce-configuration of our country which Man has witnessed ɜ can be no doubt. But though, from the evidence of the ɜits themselves, it appears impossible to arrive at any abso- conclusion as to the time involved in these changes, still, con- ing the numerous localities in which these implement-bearing have now been found, as well as other beds which, though ırently devoid of implements, yet being of the same general acter and containing the same fauna, are therefore presum- of the same date, it does appear possible that from their ɔgical position we might ascertain some epoch beyond which age cannot be carried, and thus be enabled to assign an ɜme limit to their antiquity. I believe that I am right in ng that until within the last two or three years it was the rally received opinion of geologists that the earliest known ɜ of the occupation of this portion of the globe by man were ɜrior in time to what is known as the Glacial Period. The ›very, however, of a portion of a human fibula during the ex- .tion of the Victoria Cave, near Settle, in a deposit overlain by f glacial clay containing ice-scratched pebbles, has been re- ed as conclusive that man lived in England prior to the last glacial period. I must confess that, in common with some rs, I do not regard this question as conclusively settled by such isolated piece of evidence; and that whatever further mony may eventually be adduced as to so early an occupa- of this country by man, there are, in my opinion, possibilities, is particular case, of the clay being either to some extent ıstituted or even accidentally redeposited, which make it to suspend our judgment until the evidence is corroborated. r. James Geike, however, arguing on more general and there- on safer grounds, has come to the conclusion that the ›lithic deposits are of preglacial and interglacial age, and ot, in any part, belong to postglacial times. From their com- tive absence in the midland and northern counties, and in es, Scotland, and Ireland (regions which have again and ı been subjected to the grinding action of land ice and the ›uctive influence of the sea), and from their presence in icts which were never overwhelmed by the confluent ice es, and in regions which were not submerged during the last t depression of the land in late glacial times, he thinks that ese latter districts the valley-gravels form a continuous series cords from preglacial times to the present day. He main- that the paleolithic beds dovetail into the glacial drifts, are overlapped by marine deposits thrown down during nal cold period; and, further, that it may be said for certain

that no paleolithic bed can be shown to belong to a more recent date than the mild era which preceded the last great submergence.

If this view could be accepted, there is no doubt that, as Mr. Geikie remarks, many apparent anomalies would receive a simple and satisfactory explanation.

It appears to me, however, that there are great difficulties in accepting this view; and though I do not think that an anniversary address ought in any way to partake of a controversial character, I may venture to point out that the whole of Mr. Geikie's conclusions appear to be based on his correlation of Mr. Searles V. Wood, jun.'s lower and middle glacial beds, and even his upper glacial deposits, with the lower glacial beds and till of Scotland and the northwestern districts of England. Even the general submergence of the eastern districts he assigns to another and a far earlier date than that of the Welsh area; and, indeed, he finds room for the whole of the denudation of the glacial deposits in the east of England, as well as for the excavation of the valleys as we at present find them, and the deposition of all the paleolithic gravels between those two submergences. Such views, founded on long and careful investigation, of the phenomena, though perhaps principally confined to those exhibited in Scotland, cannot be summarily and hastily dismissed; but their author will no doubt pardon those who are not prepared at once to accept them. In the mean time we must rest content with knowing that, so far as the paleolithic deposits of the east of England are concerned (and if the identity in the form of the implements affords any safe chronological index, the beds of the same character in other parts of this country and the north of France are of the same date), they are all distinctly postglacial in the sense in which that term is employed by Mr. Searles V. Wood, jun.

Take, for example, the case of Hoxne, where the implement-bearing beds repose on a trough cut out in the upper glacial boulder-clay, which itself rests on middle glacial sands and gravels.

At Icklingham, again, the paleolithic gravels occur in a valley cut through the upper glacial boulder-clay, and appear to rest on middle glacial beds. At Bedford, the valley of the Ouse is cut through the same boulder-clay, many of the pebbles from which, and the subjacent beds, form constituent parts of the paleolithic gravels. The same feature prevails in the Ealing and Acton gravels, in which transported pebbles of the older rocks are of not unfrequent occurrence.

Again, near Brandon, some of the higher gravels containing the implements show a very large percentage of the quartzite pebbles from the middle glacial beds, some few of which, indeed, have supplied the material from which implements had been chipped. There can therefore be no doubt that they belong to a period subsequent to the submergence during which the middle and upper glacial beds were deposited, and to a time when the old sea-bottom had been long enough converted into dry land for it to

become habitable by man and the numerous mammals of the Quaternary fauna.

I do not, of course, wish it in any way to be implied that I regard no part of the surface configuration of our island as of preglacial or glacial date. On the contrary, I am inclined to think that many of our principal valleys were already marked out in preglacial times, and that a large proportion of the whole number were excavated to a portion of their present depth, either by the direct action of ice, or during the last emergence of the land from beneath the waters of the sea.

But though, so far as the makers of the earliest implements hitherto discovered in Britain are concerned, we cannot safely carry back their existence to preglacial times, it by no means follows that the earliest traces of the occupation even of this part of the world by man have as yet been discovered. The Abbe Bourgeois, indeed, would carry man back to Lower Miocene times, relying on implements presumed to have been found in beds of the Calcaire de Beauce, at Thenay, near Pontlevoy. He candidly acknowledges, however, that the implements offer a complete identity with those found on the surface; and I cannot but suspect some possible error of observation as to their occurrence in the beds. Did they really belong to them, we should have the remarkable fact that at that remote period, characterized by mammals as distinct from those of the present day as the *Acerotherium* is from the Rhinoceros, or the *Mastodon* from the Elephant, primæval man was fashioning implements indistinguishable from those of neolithic times; while it is not until we come to the Sables de l'Orlëannais, which are superimposed upon the Calcaire de Beauce, that we find the earliest trace of an anthropomorphous ape, in the shape of the *Hylobates antiquus*. The *Dryopithecus*, it will be remembered, belongs to the Upper Miocene.

While speaking of the possible errors of observation, I may mention that in Sweden the Södertelje hut, which has often been cited as affording evidence of the great antiquity of the human occupation of that country, is no longer regarded as belonging to so ancient a period as was formerly assigned to it, but is considered as being of comparatively modern date.

But, returning to the main question, though for the present we seem unable to find any satisfactory evidence of the existence of man in western Europe before the glacial period, it by no means follows that none such will eventually be found. It must, moreover, never be forgotten that it is not in this part of the world that naturalists would be led to look for the cradle of the human race. This is far more probably to be sought in a warmer clime, and amidst a more luxurious vegetation, yielding throughout the year some readily available means of subsistence both to man and to animals that would serve him as food. In the earliest as well as in later times, the center of the migrations of the human race may well have lain in the far East, and the course of their

wanderings, as in after days, been even then "westward, toward the setting sun." Most remarkable it is that implements, which in form, though not in material, are indistinguishable from those of our river-drifts, have been found in stratified beds of uncertain age in Southern Africa and in the so-called lateritic deposits of the south of India.

The first discovery of paleolithic implements in Madras was made about ten years ago by Mr. R. Bruce Foote, of the Indian Geological Survey; but at that time the absence of organic remains in the beds containing the implements rendered it almost impossible to arrive at any satisfactory conclusion, either as to their age or mode of deposition. In the Records of the Geological Survey of India for the year 1873, Mr. Medlicott, however, gives an account of a quartzite implement of precisely the same class as those found in Southern India, which was discovered in the ossiferous deposits of the Narbadá valley. These deposits, which, by the late Dr. Falconer, were regarded as Pliocene, Mr. Medlicott sees reason to place among those of Pleistocene age. Whichever view may eventually prove to be correct, we have in India, as in Europe, evidence of man having coexisted with animals now long since extinct; and the *Elephas* (or *Stegodon*) *insignis*, the *Bos* and *Hippopotamus Namadicus* seem there to take the place of the allied members of the European Quaternary fauna as his contemporaries. This Narbadá discovery remains, however, a solitary instance, but must surely lead to other and even more interesting results from the investigations of those engaged in the wide field of geological researches in India.

From Borneo, where I have reason to hope there are, at the present moment, some cavern-investigations being carried on under the auspices of several Fellows of this Society, who have kindly aided me by their support, it is not, I think, unreasonable to expect that some light may be thrown on the antiquity of man in the far East. When we look back upon all the large array of facts which have been accumulated on this subject during the last sixteen years, we may find good ground for encouragement, and rest assured that in this as well as other departments of knowledge that prophecy of the wise man, which Bacon inscribed on the frontispiece of his great work, will be fulfilled—*Multi pertransibunt, et augebitur scientia.*

3. *Protriton petrolei of the Upper Coal-Measures of Muse and Millery, France, a naked-skinned Salamander.*—M. A. Gaudry, describes the specimens, to which he has given the above name, in the Bulletin of the Geological Society of France, 1875, p. 299, and presents figures of them on plates VII and VIII. Remains of skeletons of seventeen individuals have been found, indicating a variation in length from 35 to 45 millimeters. The head is much larger proportionally than in the Salamander, and the tail much shorter. The orbits are very large. There are 29 vertebræ, 3 cervical, 10 dorsal, 8 lumbar and 8 very small caudal; the ribs are very short; there are only traces of a pelvis, owing probably to its having

n ·incompletely ossified. The fore and hind limbs are about ıal in length and each 4-fingered. M. Gaudry remarks that the *ion* (*Raniceps*) *Lyelli* Wyman, of the Ohio Carboniferous, which yman was disposed to refer to the Batrachians, was probably re- ed to the Protriton; and that the *Apateon pedestris* of Münster- pel may perhaps be identical with the *Protriton petrolei.*

. *Period of Extinction of the ancient Fauna of the Island of driguez;* by M. ALPH. MILNE-EDWARDS.—A manuscript entitled elation de l' ile Rodrigue," found in the Ministère de la Marine, ng with evidence that it was published anterior to 1730 and bably not earlier than 1729, describes the species of the island sting at the time it was written, and among them all the spe- s now known to be extinct, including the *Solitaire* and the ex- ct species named by A. Milne-Edwards, *Erythromachus Leguati*, *dea megacephala*, *Athene murivora*, and *Necropsittacus Roderi- us.* In 1761, when the astronomer Pingré was living there, Solitaires had become so rare that he knew of them only from ort—none having been seen by him. The extinction of the ds probably went on rapidly between 1730 and 1760, as may inferred from the documents at the Ministère de la Marine.

The Land-tortoises became extinct somewhat later. These tor- ses were part of the regular provisions of the shipping of the mpagnie des Indes. M. Desforge-Boucher, in his reports to the mpany in 1759 and 1760, enumerates the vessels sent for the d-tortoises, and shows that they took away in less than 18 nths over 30,000. It is not surprising, the author remarks, that se animals, on so small an island, notwithstanding their fecun- y, could not withstand such means of destruction. Hungry n was the agent of extermination both for the tortoises and the ds.—*Comptes Rend.*, May, 1875.

These gigantic land tortorses, while extinct on the Islands of uritius, Rodriguez, and Réunion, are living on that of Aldabra, other of the Mascarene Group. But there is danger of its extinc- n there. To prevent this, if possible, a memorial has been lressed to the Governor and Commander-in-chief of Mauritius l its dependencies, signed by the Presidents of the Royal and yal Geographical Societies of London and other men of science, ling the attention of the Colonial Government to the subject, and ing that some means may be devised for "saving the last ex- ples of a cotemporary of the Dodo and Solitaire." The memo- . is given in full in an article in *Nature* of July 29th, by Mr. ert Günther.

. *Reliquiæ Aquitanicæ;* being Contributions to Archæology l Palæontology of Périgord and the adjoining Provinces of ıthern France; by EDOUARD LARTET and HENRY CHRISTY. ted by THOMAS RUPERT JONES, F.R.S., F.G.S., &c., Prof. l. Roy. Mil. and Staff Colleges, Sandhurst. Part XVI, May, 5. Pages 225–256 and 183–187. Plate C. IX and X.—This t of the Reliquiæ Aquitanicæ contains, among its interesting s and illustrations, a figure of a fish in outline, from a Reindeer

jawbone, referable probably to a species of *Squalius*, obtained at Laugerie Basse. A chapter on the birds whose bones occur in the caves, by Alphonse Milne-Edwards, describes relics of three Eagles, *Falco fulvus*, *Aquila clanga*, and *Haliætus albicilla*; the common Buzzard, *Buteo vulgaris*; four Falcons, *Falco communis*, *F. subbuteo*, *F. tinnunculus*, *F. milvus*; two Vultures, *Vultur barbatus* and *V. monachus*; the Owls, *Strix bubo*, *S. brachyotus*, *S. flammea*, *Noctua minor*, *Glaucideum passerinum*, *Nyctea nivea*; also, *Corvus corax*, *C. coronatus*, *C. cornix* (a northern species), *C. monedula* (the Jackdaw), *Pyrrhocorax alpinus*, *P. primigenius*, *Fregilus graculus*, *Nucifraga caryocatactes* (the Scandinavian variety), *Pica caudata* (Magpie), *Loxia curvirostra* (Cross bill, common now in northern Europe and Greenland), *Ligurinus chloris*, *Fringilla nivalis* (lives now on lofty mountains), *Alauda arvensis* (Sky-lark), *Turdus viscivorus*, *Ampelis garrulus* (Waxwing, rarely now seen in France), *Motacilla phœnicura*, *Hirundo rupestris* (Crag-Martins, now common in the Alps and Pyrenees), *Alcedo ispida* (Kingfisher), *Columba livia* (same with common pigeon), *Lagopus albus* (Willow-Grouse, found at the north and not in temperate Europe), *Lagopus mutus* (Ptarmigan, species of the Alps and Pyrenees), *Tetrao urogallus*, *T. tetrix*, *T. perdix* (Gray Partridge), *Gallus*, the Cock, (found along with bones of *Ursus spelæus*, *Rhinoceros*, &c.), *Œdicnemus crepitans*, *Rallus aquaticus*, *Gallinula chloropus*, *Grus primigenia*; *Cygnus ferus* (Wild Swan, a species of the Polar regions), *Anas boschas* (Wild Duck), *Anas querquedula* (the Summer Teal.

Many of the birds are cold-climate species, like the Reindeer with which their remains are associated. Part of them were taken into the caves for food, while others appeared to have been washed in by streams.

The remaining pages are occupied with a chapter on the Stones, Stone-flakes and implements from the cave at Les Eyzies, and the commencement of a chapter on Fossil Man from La Madelaine and Laugerie Basse, by E. T. Harvy, with two plates illustrating the same.

6. *Structure of Stone Mountain, a granitic mass in Georgia.* —The well-known "Stone Mountain" in DeKalb County, Georgia, twenty miles southeast of Atlanta, on the railroad to Augusta, is a solid bald mass of granite, by estimate 1500 to 2000 feet in height. The northeast side is perpendicular, unbroken, and smooth; the northwest side is inclined so as to be of easy ascent; while the west and southwest are so steep as to be barely accessible. On the inclined surface, the rock breaks off in layers that are from a few inches to several feet thick, which structure may be due to shrinking in cooling and to atmospheric influences, together with the heat of the sun. The rock is perfectly homogeneous with no trace of stratification—a pure, whitish granite. There is no doubt that below the surface lamination, a piece could be quarried out a quarter of a mile in length if man could command the means. This granite exists over a wide region of country and

s much used for building purposes.—*Letter from Mr. E. Hillyer of Rome, Georgia.*

7. *Genus Anomalodonta of S. A. Miller.*—The criticism with regard to the genus Anomalodonta and the use of the name, by Prof. C. A. White, published in this Journal, ix, 318 (April, 1875) is replied to by Mr. Miller in the July number of the Cincinnati Quarterly Journal of Science.

8. *Expansion of rocks by heat.*—M. Pfaff (Z. S. Geol. Ges., xxiv, 401) has determined for the expansion of the granite of the Fichtelgebirge between the ordinary temperature and a red heat (about 1,180 C.), 0·0168; for the red porphyry of the Tyrol, 0·0127; for the basalt of Auvergne, 0·0120.

9. *Geology of Eastern Massachusetts.*—Mr. W. W. Dodge has a paper entitled "Notes on the Geology of Eastern Massachusetts in the Proceedings of the Boston Society of Natural History, February 3, 1875, vol. xvii, p. 388.

10. *South American Geology.*—Mr. A. Hyatt has described, in the Proceedings of the Boston Society of Natural History, xvii, 365, a number of species of Jurassic and Cretaceous Ammonites from northern Bolivia and Peru, collected by Prof. James Orton. For the Cretaceous species which were formerly referred to the genus Ceratites, and which Quenstedt had shown to be not of this genus, but Ammonites, Mr. Hyatt has instituted the new genus *Buchiceras*—named in honor of Von Buch.

11. *On the composition of Coal and on the methods of arriving at it, with deductions and remarks on Coal in general; illustrated on a sample of Coal from the Lower Coal Series of Missouri, and on the Water Supply of Columbia, Missouri;* by P. Schweitzer, Ph.D., Prof. Chem. State University of Missouri. Contributions from the laboratory of the University, pp. 156–193, published in the Catalogue of the University, Jefferson City, 1875.—Prof. Schweitzer gives the results of detailed analyses of the coal, including its impurities. He concludes that the sulphur in the coal above what is combined with iron is in the free state (through the alteration of pyrite, FeS_2), and not in combination with organic matter.

12. *Revue de Géologie pour les Années* 1871 *and* 1872, par M. Delesse et M. de Lapparent. Tome xi, 262 pp. 8vo, Paris, 1875.—Geologists will find this Annual a very valuable aid in keeping up with the progress of the science. It is full in Lithological Geology, and gives abstracts also of the more important papers in Historical, Geographical and Dynamical Geology.

13. *Devonian trachyte of Queensland, Australia.*—The trachyte of Gladstone, intersecting Devonian rocks, has the composition nearly of that of the Puy-de-Dome. Daintree obtained, Silica 67·80, alumina 14·67, sesquioxide of iron 5·35, potash 5·65, soda 4·60, water of constitution 0·70, do. hygroscopic 0·60=99·37.—Q. *J. Geol. Soc.*, xxviii, 312.

14. *Phosphate of Lime of Bamle, Norway.*—Occurs in nearly horizontal beds, two to six feet thick in crystalline schists, and is

whitish and crystalline. An article on the localities of Southern Norway, by MM. Brögger and Reusch, is soon to appear. Among the associated minerals to be described in it, are anorthite in large and beautiful crystals, resembling the lepolite or amphodelite of Orijarfvi, and enstatite in crystals four inches long. The latter occurs changed to serpentine.—*Letter to J. D. Dana from Professor vom Rath, of Bonn.*

15. *Mineralogische Notizen, von Friederich Hessenberg.* Neue Folge, Neuntes Heft. 26 pp. 4to, with three plates. Frankfurt a. M., 1875. (Christian Winter).—This number of the Mineralogical Notices of the excellent crystallographer, F. Hessenberg, recently deceased, was edited by his friend, Dr. F. Scharff. It contains descriptions of crystals of Xenotime from Tavetsch; of Binnite from Imfeld in the Binnenthal, and of Calcite from Rödefiörd in Iceland and Andreasberg, and is illustrated by most excellent figures on the three plates.

This valuable memoir, like the preceding of the two series, is published in the *Abhandlungen der Senkenbergischen Naturforschenden Gesellschaft in Frankfurt a. M.*

16. *Tables for the Determination and Classification of Minerals found in the United States;* by James C. Foye, A M., Prof. Chem. Phys. in the Lawrence University. 38 pp. 12mo. Chicago, 1875. (Jansen, McClurg & Co.)—The tables contained in this little work are arranged with reference both to the blowpipe and physical characters of minerals, and will be found useful for the purposes intended.

17 *Observations on the Phenomena of Plant life: a Paper presented to the Massachusetts Board of Agriculture;* by W. S. Clark, Pres. State Agric. College, Amherst, Mass. 112 pp. 8vo. Boston, 1875. From the 22nd Ann. Rep. of the Secretary of the Mass. State Board of Agriculture.—The author presents in this paper the results of his new experiments on the phenomena of plant life, in continuation of those in a former Report, noticed in vol. vii of this Journal on page 512, and sustaining the same conclusions.

18 *Forest Flora of N. W. and Central India, a Handbook of the Indigenous Trees and Shrubs of those Countries.* Commenced by the late J. Lindsay Stewart, M.D.; continued and completed by Dietrich Brandis, Ph.D., Inspector General of Forests to the Government of India. London: Allen & Co., 1874. 8vo, and Atlas, 4to. Published under the authority of the Secretary of State for India in Council. Prepared at the Herbarium of the Royal Gardens, Kew. —"The object of this work is entirely practical," and an excellent practical work it is. It was written "especially for those who have the care of the public forests in the different provinces of India," has been preceded by the Flora Sylvatica of Madras, by Colonel Beddome, and is to be followed by the Forest Flora of British Burma, now preparing by Mr. Kurz. There is a good quarto atlas of 70 plates, drawn and lithographed by Fitch. A. G.

19. *Flora Brasiliensis*, Fasc. 66, issued in February last, contains the *Aristolochiaceæ*, elaborated by Dr. Masters: comprises the unique *Holostylis*, and 48 species of *Aristolochia*. Among the figures, one is given of the striking *A. Brasiliensis*, now rather common in conservatories. It appears that one of the kinds of *Guaco*, famous antidotes to snake-bites, is furnished by an *Aristolochia*, viz., *A. maxima* of Guiana and Venezuela. Fasc. 67, published in March last, comprises three or four orders, all small, except the *Vochysiaceæ* (by Warming), which is especially Brazilian. The *Callitrichiaceæ* are treated with much fullness as to general characters, by Hegelmaier. The affinity is still regarded as uncertain; the recent reclamation of *Callitrichiæ* to the *Halorageæ* is not responded to; still it is thought that the rarest known genus is *Hipprius*, but that its relationship is uncertain. It appears that only one species is known in Brazil, *C. deflexa*, of which a variety, *Austini*, is *C. Austini* of Engelmann. As *C. deflexa* and *C. Austini* were published in the same year (1867), we may, perhaps, quite properly retain Engelmann's name.

The *Onagraceæ* are by M. Micheli of Geneva. The most important genus is *Jussiæa*, with 36 species, under three sections. Our northern *J. decurrens* is one of the species, and is well figured. So is the *J. oocarpa* of C. Wright in Grisebach's *Pl. Cubenses*, on which a genius, *Oocarpon* is here established. Of *Epilobium* there is only *E. tetragonum*; of *Fuschia* and *Œnothera* three or four species each. A. G.

20. *Different effects of the same temperature upon the same species of plants under different latitudes.* A communication made by M. Alph. DeCandolle to the Academy of Sciences, Paris, reported in Comptes Rendus, June 7, 1875.—As the temperature rises in spring, it is thought that vegetation is more powerfully or promptly acted upon in higher than in lower latitudes. To test this, M. DeCandolle formerly had the seeds of three or four common annuals sent him from northern and southern Europe, which he raised together at Geneva. One of the selected species, the common Groundsel, confirmed this opinion, the northern seeds showing a decided advantage in precocity; while the uncertain or varying result of the two other plants tried were attributed to the fact that being of somewhat variable species they probably represented unlike forms. It occurred to M. DeCandolle to test the matter in a different way, and upon trees. At some time last winter he had branches sent him from Montpellier of *Populus alba*, *Carpinus Betulus*, *Liriodendron*, and *Catalpa*. These were paired with similar branches taken from trees at Geneva; and, after a common sojourn in a cool room long enough to make sure of complete penetration by the same temperature, the pairs were placed in glasses of water, with some sand at bottom, and kept in a warmed room under exactly the same conditions. The *Catalpa* requiring a higher temperature to start it, and coming, therefore, much later into leaf, was made the subject of a subse-

quent experiment. That with the other three commenced on the 4th of February. The result was that the German trees leafed out first. In the case of the Poplar there was a difference of about 23 days in favor of the individual of the colder locality; in that of the *Carpinus* about 16 days; and in that of the Tulip-tree a similar result was obtained when the comparison was restricted to buds of the same size and degree of development. The *Catalpa* of the northern locality developed 20 days in advance of the other.

Why should the same temperature act more powerfully and promptly upon the plant of the higher latitude? DeCandolle refers it to two causes, attributing, however, most importance to the second. First, to a natural selection of the buds which has induced the boreal precocity. "The buds of a tree are in a continual struggle. The later, like the badly placed ones, develop imperfect branches, which are oftener stifled. The most precocious prevail, unless indeed they suffer from frost. In this way comes a selection and a successive adaptation of the tree to the climate." And he goes on to show that what effectuates this result is, that every peculiarity of a bud is ordinarily reproduced year after year in the succeeding growths. As a case in point he mentions a well known Horse-chestnut tree in the environs of Geneva, upon which the owner, in the year of 1822 or 1823, detected a single branch bearing double flowers; this still continues, and has all along borne double flowers, and shows no tendency to revert to the ordinary simple-flowered condition of the rest of the tree. Grafts have been taken from it, and it is thought to be the original of all the double-flowered Horse chestnuts in the world. Although this may well illustrate how the precocity may come to pass; yet DeCandolle doubts whether this selection of branches produces much effect. Because, in the north precocity seems as likely to be a disadvantage as an advantage, while at the south it ought generally to be an advantage, yet the southern individual requires more heat for vegetation. And it is yet to be proved that an individual tree becomes any better adapted to the climate as it increases in years. The general idea is that a tree does not acclimatize. The principal cause of this difference in the vegetation of northern and southern individuals, in DeCandolle's opinion, is the complete hibernal repose of the former, rendering it somehow more susceptible to the heat of spring; though in what way is not stated. We would add that if the suggested explanation through bud-selection be not the true one in the case of trees, owing to the general fixity of character in buds giving small room for variation, yet the explanation may be reached on this line by taking the fructification into account. DeCandolle alludes, at the beginning of his paper, to the case of the precocious cereal grains of the north, only to remark that some naturalists are unwilling to argue from cultivated to spontaneous plants. But it seems to us that natural selection would operate similarly upon trees, inducing precocious races better adapted to the short summer, the only difference being that much more time would be required for a tree to fix a race than for an annual. An objection

to this view offers itself, however, in the fact that the precocious vernal development was apparent, although less marked, in *Liriodendron* and *Catalpa*, of which very few generations can have been raised in Europe. A. G.

21. DR. JOHN EDWARD GRAY.—A "List of Books, Memoirs and Miscellaneous Papers," commenced in 1871 and added to up to the close of 1873, is Dr. Gray's own record of his publications. Mr. J. Sanders has appended those of still later date, and printed it in an 8vo pamphlet of 58 pages. The total number of papers is 1162! Some curious and characteristic notes are interspersed.

22. *North American Oniscida;* A. STUXBERG has a paper on the North American Oniscida in the Ofversigt K. V.-Ak. Förhandlingar, 1875, No. 2, Stockholm, reviewing the described species, and adding descriptions of several new species.

III. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *American Association for the Advancement of Science.*—The twenty-fourth annual meeting of the Association was opened at Detroit, on Wednesday, the 11th of August, under the presidency of J. E. Hilgard, Esq., of the Coast Survey. An address of welcome to the city was delivered at the opening session, by Hon. C. J. Walker. The address of the retiring president, Dr. John L. LeConte, was delivered on Thursday evening. It will be published in the following number of this Journal, in which also some account of the papers read at the meeting will be given.

2. *Cincinnati Society of Natural History.*—This Society has received a bequest of $50,000 from Mr. Bodman, who had been one of its members.—*Cincinnati Qu. J. Sci.*, ii, 286, July.

3. *Preliminary Report upon a Reconnaissance through Southern and Southeastern Nevada*, made in 1869 by First Lieut. G. M. WHEELER, U. S. A., and First Lieut. D. W. LOCKWOOD, U. S. A., under the orders of Brig. Gen. E. O. C. Ord, commanding Department of California, Engineer Department, U. S. Army. 72 pp. 4to, Washington, 1875.—This report contains a general description of the country passed through; notes on the Indians; brief accounts of the mines and mining settlements; results of astronomical observations for determining longitudes and latitudes, etc.

In latitude 38° 58′, on "Wheeler's" Peak, the upper limit of vegetation was found to be at 11,500 feet above the sea-level.

4. *The Mosaic Account of Creation, The Miracle of To-day;* by CHARLES B. WARRING. 292 pp. 12mo. New York, 1875. (J. W. Schermerhorn & Co.)—The author, who regards his method of interpretation very literal, makes the third day of Genesis, the day of the appearance of dry land and the creation of vegetation, to include all of geological history up to the Glacial period of the Quaternary. A change in the obliquity of the ecliptic is made the event of the fourth day, and the source of the Glacial cold. Then, with regard to the fiat on the fifth day, "Let the waters bring forth," and that of the sixth, "Let the earth bring forth," he says: "The waters, during the melting glaciers, were compar-

atively soon ready for animal life, but the land required a longer time for preparation."

6. *Mineral Collection of Dr. Krantz.*—This extensive collection of minerals has been purchased for the University of Bonn, and is now under the charge of Professor vom Rath.

G. P. DESHAYES, the distinguished paleontologist of Paris, died on the 9th of June last, in his 79th year, at his residence in Boran (Oise).

Proceedings of the Semi-centennial Celebration of the Rensselaer Polytechnic Institute, Troy, N. Y., held June 14-18, 1874. 8 pp. 8vo. Troy, 1875. The Rensselaer School is the oldest Scientific School in the country, dating from 1824.

Papers read before the Pi Eta Society, 1875. Rensselaer Polytechnic Institute, Troy, N. Y. 74 pp. 12mo. Troy, 1875. Printed by the Society. Among the papers included, one, by Prof. H. A. Rowland, treats of sympathetic vibration, and another, by Wm. H. Burr, of "Some of the stresses in the members of the Swing-bridge."

Field and Forest. Devoted to General Natural History. Bulletin of the Potomac-side Naturalists' Club. Charles R. Dodge, Editor. No. 1, vol. i, 8 pp. 8vo. Washington, 1875. Contains description of "a new Grasshopper from Arizona," "*Eremobia magna*," by Cyrus Thomas, and some botanical notes, with the Proceedings of meetings of the Club.

Bulletin of the Bussy Institution (Jamaica Plains, Boston.) Harvard University. Part IV, 1875. Contains the results of much study and investigation of questions connected with the department of Agriculture.

Report of the Commission of Engineers appointed to investigate and report a permanent plan for the reclamation of the alluvial basin of the Mississippi River subject to inundation. 15 pp. 8vo, with maps. Washington, 1875. Contains much valuable matter on the levees, floods and alluvial basin of the Mississippi.

History of the Birds of Europe, including all the species inhabiting the Western Palaearctic Region; by H. E. Dresser, F.Z.S. Parts 35 and 36, completing the 3d volume. Office of the Zoological Society, London.

A Report on the Hygiene of the U. S. Army, with descriptions of Military Posts. 568 pp. 8vo. Washington, 1875. Circular No. 8.: War Department, Surgeon General's Office, Washington, May 1, 1875.

Addition to the Paper on "Volcanic Energy: an attempt to develop its true Origin and Cosmical Relations." By ROBERT MALLET, F.R.S. 9 pp. 4to. Read before the Roy. Soc., May 7, 1874. Phil. Trans., clxv, pt. 1.

On the temperature attainable by rock-crushing and its consequences, by ROBERT MALLET, F.R.S. 13 pp. 8vo. Phil. Mag. for July, 1875.

Supplement to the Extinct Batrachia and Reptilia of N. America; by E. D. Cope. pp. 261-272 of vol. xv of the Trans. Amer. Phil. Soc. Philadelphia. 1875.

Mineral Deposits in Essex Co., Mass., especially in Newbury and Newburyport, with a map and notes; by Charles J. Brockway. 60 pp. 12mo. Newburyport. 1875.

Reports on the Meteorological, Magnetic and other Observatories of the Dominion of Canada, for 1874; being the Annual Reports of the Meteorological Office. 318 pp. 8vo. Ottawa. 1875.

The Gold Fields of Yesso. Geological Survey of Hokkaido. Report by H. S. Munroe. 80 pp. 8vo. Tokio, Japan. 1875.

Notes on the Geology of West Virginia, No II; by John J. Stevenson, Prof. Geol. Univ. New York. Proc. Amer. Phil. Soc. for Feb., 1875.

The Geological Relations of the Lignitic Groups; by John J. Stevenson. Proc. Amer. Phil. Soc. for June, 1875. Decides in favor of the Cretaceous age of the Lignitic beds, but without bringing forward any more decisive facts than were before published.

Abstracts and Results of Magnetical and Meteorological Observations at the Magnetic Observatory, Toronto, Canada, from 1841 to 1871 inclusive. 60, 26, 56 and 108 pages.

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[THIRD SERIES.]

ART. XXXIII.—*Address of Dr. John L. LeConte, the retiring President of the American Association for the Advancement of Science, at the meeting in August, 1875, at Detroit.*

THE founders of science in America, and the other great students of nature, who have in previous years occupied the elevated position in which I now stand, have addressed you upon many momentous subjects. In fulfilling the final duty assigned to your presidents by the laws of the Association, some have spoken to you in solemn and wise words concerning the duties and privileges of men of science, and the converse duties of the nation toward those earnest and disinterested promoters of knowledge. Others again have given you the history of the developement of their respective branches of study, and their present condition, and have, in eloquent diction, commended to your gratitude those who have established on a firm foundation the basis of our modern systems of investigation.

The recent changes in our constitution, by which you are led to expect from your two vice-presidents, and from the chairman of the Chemical Sub-section, addresses on the progress made during the past year, restrain me from invading their peculiar fields of labor, by alluding to scientific work which has been accomplished since our last meeting. While delicacy forbids me from so doing, I am equally debarred from repeating to you the brief sketch I endeavored to give at a former meeting *

* Proceedings Am. Assoc. Adv. Sci., xxi, Portland.

of the history, and present condition of Entomology in the United States.

But it has appeared to me that a few thoughts, which have impressed themselves upon my mind, touching the future results to be obtained from certain classes of facts not yet fully developed on account of the great labor required for their proper comparison, may not be without value. Even if the facts be not new to you, I hope to be able, with your kind attention, to present them in such way as to be suggestive of the work yet to be done.

It has been perhaps said, or at least it has been often thought, that the first mention of the doctrine of evolution, as now admitted to a greater or less degree by every thinking man, is found in Ecclesiastes, i, 9: "The thing that hath been is that which shall be; and that which is done is that which shall be done; and there is no new thing under the sun. Is there anything whereof it may be said, see, this is new? It hath been already of old time, which was before us."

Other references to evolutionary views in one form or another occur in the writings of several philosophers of classic times, as you have had recent cause to remember.

Whether these are to be considered as an expression of a perfect truth in the very imperfect language which was alone intelligible to the nation to whom this sacred book was immediately addressed on the one hand: and the happy guesses of philosophers, who by deep intuition had placed themselves in close sympathy with the material universe on the other hand, I shall not stop to inquire. The discussion would be profitless, for modern science in no way depends for its magnificent triumphs of fact and thought upon any utterances of the ancients. It is the creation of patient, intelligent labor of the last two centuries, and its results can be neither confuted nor confirmed by anything that was said, thought or done, at an earlier period. I have merely referred to these indications of doctrines of evolution to recall to your minds that the two great schools of thought, which now divide philosophers, have existed from very remote times. They are, therefore, in their origin, probably independent of correct scientific knowledge

You have learned from the geologists, and mostly from those of the present century, that the strata of the earth have been successively formed from fragments more or less comminuted by mechanical action, more or less altered by chemical combination and molecular rearrangements. These fragments were derived from strata previously deposited, or from material brought up from below, or even thrown down from above, or from the debris of organic beings which extracted their mineral constituents from surrounding media. Nothing new has been added, everything is old; only the arrangement of the parts is

new, but in this arrangement definite and recognizable unchanged fragments of the old frequently remain. Geological observation is now so extended and accurate that an experienced student can tell from what formation, and even from what particular locality, these fragments have been derived.

I wish to show that this same process has taken place in the organic world, and that by proper methods we can discover in our fauna and flora the remnants of the inhabitants of former geologic times, which remain unchanged, and have escaped those influences of variation which are supposed to account for the differences in organic beings of different periods.

Should I succeed in this effort we will be hereafter enabled in groups of animals which are rarely preserved in fossil condition to reconstruct, in some measure, the otherwise extinct faunæ, and thus to have a better idea of the sequence of generic forms in time. We will also have confirmatory evidence of certain changes which have taken place in the outline of the land and the sea. More important still, we will have some indications of the time when greater changes have occurred, the rock evidence of which is now buried at the bottom of the ocean, or perhaps entirely distroyed by erosion and separation. Of these changes, which involved connections of masses of lands, no surmise could be made except through evidence to be gained in the manner of which I am about to speak.

My illustrations will naturally be drawn from that branch of zoology with which I am most familiar; and it is indeed to your too partial estimate of my studies in that science that I owe the privilege of addressing you on the present occasion.

There are, as you know, a particular set of Coleoptera which affect the seashore; they are not very numerous at any locality, but among them are genera which are represented in almost every country of the globe. Such genera are called cosmopolitan, in distinction to those which are found only in particular districts. Several of these genera contain species which are very nearly allied, or sometimes, in fact, undistinguishable and therefore identical, along extended lines of coasts.

Now it happens that some of these species, though they never stray from the ocean shore inland, are capable of living upon similar beaches on fresh water lakes, and a few are found in localities which are now quite inland.

To take an example, or rather several examples together, for the force of the illustration will be thereby greatly increased.

Along the whole of the Atlantic, and the greater part of the Pacific coast of the United States, is found in great abundance on sand beaches, a species of Tiger-beetle, *Cicindela hirticollis*, an active, winged, and highly predaceous insect; the same species occurs on the sand beaches of the great lakes, and were it con-

fined to these and similar localities, we would be justified in considering it as living there in consequence solely of the resemblance in the conditions of its existence. But it is also found, though in much less abundance, in the now elevated region midway between the Mississippi and Rocky Mountains. Now, this is the part of the continent which, after the division of the great intercontinental gulf in Cretaceous times, finally emerged from the bed of the sea, and was in the early and middle Tertiary converted into a series of fresh water lakes. As this insect does not occur in the territory extending from the Atlantic to beyond the western boundary of Missouri, nor in the interior of Oregon and California, I think that we should infer that it is an unchanged survivor of the species which lived on the shores of the Cretaceous ocean, when the intercontinental gulf was still open, and a passage existed, moreover, toward the southwest, which connected with the Pacific

The example I have given you of the geographical distribution of *Cicindela hirticollis* would be of small value were it an isolated case; nor would I have thought it worthy of occupying your time on an occasion like this, which is justly regarded as one for the communication of important truths. This insect, which I have selected as a type for illustrating the methods of investigation to which I invite your attention, is, however, accompanied more or less closely by other Coleoptera, which like itself, are not particular as to the nature of their food so long as it be other living insects, and apparently are equally indifferent to the presence of large bodies of salt water. First, there is *Cicindela lepida*, first collected by my father near Trenton, N. J., afterward found on Coney Island, near New York, and received by me from Kansas and Wisconsin; not, however, found west of the Rocky Mountains. This species, thus occurring in isolated and distant localities, is probably in progress of extinction, and may or may not be older than *Cicindela hirticollis*. I am disposed to believe, as no representative species occurs on the Pacific coast, and from its peculiar distribution, that it is older. Second, there is *Dyschirius pallipennis*, a small Carabide, remarkable among the other species of the genus by the pale wing covers, usually ornamented with a dark spot This insect is abundant on the Atlantic coast from New York to Virginia, unchanged in the interior parts of the Mississippi Valley, represented at Atlantic City, New Jersey, by a large and quite distinct specific form *D. sellatus*, and on the Pacific coast by two or three species of larger size and different shape, which, in my less experienced youth, I was disposed to regard as a separate genus, *Akephorus* This form is, therefore, in a condition of evolution - how, I know not—our descendants may. The Atlantic species are

winged, the Pacific one, like a large number of insects of that region, are without wings.

Accompanying these are Coleoptera of other families, which have been less carefully studied, but I will not trespass upon your patience by mentioning more than two. *Bledius pallipennis* (*Staphylinidæ*) is found on salt marshes near New York, on the Southern sea-coast and in Kansas—*Ammodonus fossor*, a wingless Tenebrionide, Trenton, sea-shore near New York, and Valley of the Mississippi at St. Louis; thus nearly approximating *Cicindela lepida* in distribution.

We can thus obtain by a careful observation of the localities of insects, especially such as affect sea-shore or marsh, and those which being deprived of their favorite surroundings have shown, if I may so express myself, a patriotic clinging to their native soil, most valuable indications in regard to the time at which their unmodified ancestors first appeared upon the earth. For it is obvious that no tendency to change in different directions by "numerous successive slight modifications"* would produce a uniform result in such distant localities, and under such varied conditions of life. Properly studied, these indications are quite as certain as though we found the well preserved remains of these ancestors in the mud and sand strata upon which they flitted or dug in quest of food.

Other illustrations of survivals from indefinitely more remote times I will give you, from the Coleopterous fauna of our own country, though passing time admonishes me to restrict their number.

To make my remarks intelligible, I must begin by saying that there are three great divisions of Coleoptera, which I will name in the order of their complication of structural plan: 1. Rhynchophora; 2. Heteromera; 3. Ordinary or normal Coleoptera; the last two being more nearly allied to each other than either is to the first. I have in other places exposed the characters of these divisions, and will not detain you by repeating them.

From paleontological evidence derived from other branches of zoology we have a right to suppose, if this classification be correct, that these great types have been introduced upon the earth in the order in which I have named them.

Now, it is precisely in the first and second series that the most anomalous instances of geographical distribution occur; that is to say, the same or nearly identical genera are represented by species in very widely separated regions, without occurring in intermediate or contiguous regions. Thus there is a genus *Emeax*, founded by Mr. Pascoe, upon an Australian species, which, when I saw it, I recognized as belonging to

* Origin of Species, 1869, 227.

Nyctoporis, a California genus, established many years before, and in fact barely specifically distinct from *N. galeata*. Two other examples are *Othnius* and *Eupleurida*, United States genera, which are respectively equivalent to *Elacatis* and *Ischalia*, found in Borneo. Our native genera, *Eurygenius* and *Toposcopus*, are represented by scarcely different forms in Australia. All these belong to the second series (*Heteromera*), and the number of examples might be greatly increased with less labor on my part than patience on yours.

A single example from the Rhynocophora, and I will pass to another subject.

On the sea-coast of California, extending to Alaska, is a very anomalous insect whose affinities are difficult to discern, called *Emphyastes fucicola*, from its occurrence under the sea-weed cast up by the waves. It is represented in Australia by several species of a nearly allied genus *Aphela*, found in similar situations.

In all entomological investigations relating to geographical distribution we are greatly embarrassed by the multitude of species, and by the vague and opinionative genera founded upon characters of small importance. The Coleoptera alone, thus far described, amount to over 60,000 so-called species, and there are from 80,000 to 100.000 in collections. Under these circumstances it is quite impossible for one person to command either the time or the material to master the whole subject, and, from the laudable zeal of collectors to make known what they suppose to be new objects, an immense amount of synonymy must result. Thus, in the great Catalogus Coleopterorum of Gemminger and Harold, a permanent record of the untiring industry of those two excellent entomologists, species of the genus *Trechicus*, founded by me upon a small North American insect, are mentioned under five generic names, only one of which is recognized as a synonym of another. These generic headings appear in so remote pages of the volume as 135, 146 and 289.

The two closely allied genera of Rhynchophora mentioned above are separated by no less than 168 pages. It is, therefore, plain that, before much progress can be made in the line of research which I have proposed to you, whereby we may recover important fragments of the past history of the earth, entomology must be studied in a somewhat different manner from that now adopted. The necessity is everyday more apparent that descriptions of heterogeneous material are rather obstructive than beneficial to science, except in the case of extraordinary forms likely to give information concerning geographical distribution or classification. Large typical collections, affording abundant material for comparison, for the

approximation of allied forms, and the elimination of doubtful ones, must be accumulated; and in the case of such perishable objects as those we are now dealing with, must be placed where they can have the protecting influences both of climate and personal care.

At the same time, for this investigation the study of insects is peculiarly suitable: not only on account of the small size, ease of collecting, and little cost of preserving, the specimens, but because, from their varied mode of life in different stages of development, and perhaps for other reasons, the species are less likely to be destroyed in the progress of geological changes. (For a fuller discussion of these causes and of several other subjects which are briefly mentioned in this address, the reader may consult an excellent memoir by my learned friend, Mr. Andrew Murray, "On the Geographical Relations of the Chief Coleopterous Faunæ," Journal of Linnæan Society, Zoology, vol. xi.) Cataclysms and submergences, which would annihilate the higher animals, would only float the temporarily asphyxiated insect, or the tree trunks containing the larvæ and pupæ to other neighboring lands. However that may be, I have given you some grounds for believing that many of the species of insects now living existed in the same form before the appearance of any living genera of mammals, and we may suppose that their unchanged descendants will probably survive the present mammalian fauna, including our own race.

I may add, moreover, that some groups, especially in the Rhynchophora, which, as I have said above, I believe to be the earliest introduced of the Coleoptera, exhibit with compact and definite limits, and clearly defined specific characters, so many generic modifications that I am compelled to think that we have in them an example of long sought unbroken series extending, in this instance, from early Mesozoic to the present time, and of which very few forms have become extinct.

I have used the word species so often that you will doubtless be inclined to ask, what, then, is understood by a species? Alas! I can tell you no more than has been told recently by many others. It is an assemblage of individuals, which differ from each other by very small or trifling and inconstant characters, of much less value than those in which they differ from any other assemblage of individuals. Who determines the value of these characters? The experienced student of that department to which the objects belong. Species are, therefore, those groups of individuals representing organic forms which are recognized as such by those who from natural power and education are best qualified to judge.

You perceive, therefore, that we are here dealing with an

entirely different kind of information from that which we gain from the physical sciences; everything there depends on accurate observation, with strict logical consequences derived therefrom. Here the basis of our knowledge depends equally on accurate and trained observation, but the logic is not formal but perceptive.

This has been already thoroughly recognized by Huxley* and Helmholtz,† and others, but we may properly extend the inquiry into the nature and powers of this æsthetic perception somewhat further. For it is to this fundamental difference between biological and physical sciences that I will especially invite your attention.

Sir John Lubbock,‡ quoting from Oldfield,§ mentions that certain Australians "were quite unable to realize the most vivid artistic representations. On being shown a picture of one of themselves, one said it was a ship, another a kangaroo, not one in a dozen identifying the portrait as having any connection with himself.

These human beings, therefore, with brains very similar to our own, and, as is held by some persons, potentially capable of similar cultivation with ourselves, were unable to recognize the outlines of even such familiar objects as the features of their own race. Was there any fault in the drawing of the artist? Probably not. Or in the eye of the savage? Certainly not, for that is an optical instrument of tolerably simple structure, which cannot fail to form on the retina an accurate image of the object to which it is directed. Where then is the error? It is the want of capacity of the brain of the individual (or rather of the race in this instance) to appreciate the resemblance between the outline, the relief, the light and shade of the object pictured, and the flat representation in color: in other words, a want of "artistic tact" or æsthetic perception.

A higher example of a similar phenomenon I have myself seen; many of you, too, have witnessed it, for it is of daily occurrence. It is when travelers in Italy, having penetrated to the temple of Art, even the hall of the Tribune at Florence, stand in presence of the most perfect works of art which it has

* "A species is the smallest group to which distinctive and invariable characters can be assigned."—*Principles and Methods of Palæontology, Smithsonian Report*, 1869, 378

† "I do not mean to deny that in many branches of these sciences, an intuitive perception of analogies and a certain artistic tact play a conspicuous part. In natural history * * * it is left entirely to this tact, without a clearly definable rule, to determine what characteristics of species are important or unimportant for purposes of classification, and what divisions of the animal or vegetable kingdom are more natural than others."—*Relation of the Physical Sciences to Science in General; Smiths. Report*, 1871, 277.

‡ Prehistoric Times, p. 440.

§ On the Aborigines of Australia, Trans. Ethnological Soc., New series, vol. iii.

been given to man to produce, and gaze upon them with the same difference that they would show to the conceptions of mediocre artists exhibited in our shops. Perhaps they would even wonder what one can find to admire in the unrivalled collection which is there assembled. There is surely wanting in the minds of such persons that high, æsthetic sense, which enables others to enter into spiritual harmony with the great artists whose creations are before them. Creations I said, and I use the word intentionally. If there is one power of the human soul, which more nearly than any other approaches the faculty of creation, it is that which the almost inspired artist develops out of a rude block of stone, or out of such mean materials as canvas and metallic pastes of various colors, figures which surpass in beauty and in power of exciting emotion the objects they profess to represent.

Yet these unæsthetic and nonappreciative persons are just as highly educated, and in their respective positions as good and useful members of the social organism, as any that may be found. I maintain only, they would never make good students of biology.

In like manner, by way of illustrating the foregoing observations, there are some, who, in looking at the phenomena of the external universe, may recognize only chance, or the "fortuitous concourse of atoms," producing certain resultant motions. Others, having studied more deeply the nature of things, will perceive the existence of laws, binding and correlating the events they observe. Others again, not superior to the latter in intelligence, nor in power of investigation, may discern a deeper relation between these phenomena, and the indications of an intellectual or æsthetic or moral plan, similar to that which influences their own actions, when directed to the attaining of a particular result.

These last will recognize in the operations of nature the direction of a human intelligence, greatly enlarged, capable of modifying at its will influences beyond our control; or they will appreciate in themselves a resemblance to a superhuman intelligence which enables them to be in sympathy with its actions. Either may be true in individual instances of this class of minds; one or the other must be true; I care not which, for to me the propositions are in this argument identical, though in speculative discussions they may be regarded as at almost the opposite poles of religious belief. All that I plead for is this, that those who have not this perceptive power, and who in the present condition of scientific discussion are numerically influential, will have tolerance for those who possess it; and that the idea of the latter may not be entirely relegated to the domain of superstition and enthusiasm.

In the case of want of perception of the Australian, a very simple test can be applied. It is only to photograph the object represented by the artist, and compare the outlines and shades of the photograph with those of the picture. If they accord within reasonable limits, the picture is correct to that extent; at least, however bad the artist, the human face could never be confounded with a ship or a kangaroo.

Can we apply a similar test to the works of nature? I think we can. Suppose that man—I purposely use the singular noun to indicate that all human beings of similar intelligence and education working toward a definite end, will work in a somewhat similar manner—suppose, then, I say, that man, endeavoring to carry out some object of importance, devises a method of so doing, and creates for that purpose a series of small objects, and we find that these small objects naturally divide and distribute themselves in age and locality, in a similar manner to that in which the species of a group of organisms are divided in space, and distributed in time; and that the results of man's labor are thus divided and distributed on account of the necessary inherent qualities of his intelligence and methods of action, is not the resemblance between human reason and the greater powers which control the manifestations of organic nature apparent?

I now simply present to you this investigation. Time is wanting for me to illustrate it by even a single example, but I feel sure that I have in the minds of some of you already suggested several applications of it to the principle I wish to teach—the resemblance in the distribution of the works of nature to that of human contrivances evolved for definite purposes.

If this kind of reasoning commends itself to you, and you thus perceive resemblances in the actions of the Ruler of the Universe to those of our own race, when prompted by the best and highest intellectual motives, you will be willing to accept the declaration of the ancient text, "He doeth not evil, and abideth not with the evil inclined. Whatever he hath done is good";* or that from our own canon of Scripture, "With him is wisdom and strength, he hath counsel and understanding.†

The æsthetic character of natural history, therefore, prevents the results of its cultivation from being worked out with the precision of a logical machine, such as with correct data of observation and calculation would be quite sufficient to formulate the conclusions of physical investigation. According as the perception of the relations of organic beings among themselves becomes more and more enlarged, the interpretation of these relations will vary within limits; but we will be continually approximating higher mental or spiritual truth.

* Desatir, p. 2. † Job, xii, 13.

This kind of truth can never be revealed to us by the study of inorganic aggregations of the universe. The molar, molecular and polar forces, by which they are formed, may be expressed, so far as science has reduced them to order, by a small number of simply formulated laws, indicative neither of purpose nor intelligence, when confined within inorganic limits. In fact, taking also the organic world into consideration, we as yet see no reason why the number of chemical elements known to us should be so large as it is, and go on increasing almost yearly with more minute investigation. To all appearance the mechanical and vital structure of the universe would remain unchanged if half of them were struck out of existence.

Neither is there any evidence of intelligence or design in the fact that the side of the moon visible to us exhibits only a mass of volcanoes. Yet upon the earth, without the volcano and the earthquake and the elevating force of which they are the feeble indications, there would be no permanent separation of land and water; consequently no progress in animal and vegetable life beyond what is possible in the ocean. To us, then, as sentient beings, the volcano and the earthquake, viewed from a biological standpoint, have a profound significance.

It is indeed difficult to see in what manner the student of purely physical science is brought to a knowledge of any evidences of intelligence in the arrangement of the universe. The poet, inspired by meditating on the immeasurable abyss of space, and the transcendent glories of the celestial orbs, has declared,

> "The undevout astronomer is mad."

And his saying had a certain amount of speciousness, on account of the magnitude of the bodies and distances with which the student of the stars is concerned. This favorite line is, however, only an example of what an excellent writer has termed "the unconscious action of volition upon credence," and it is properly in the correlations of the inorganic world that we may hope to exhibit, with clearness, the adaptations of plan prefigured and design executed.

In the methods and results of investigation, the mathematician differs from both the physicist and the biologist. Unconfined, like the former, by the few simple relations by which movements in the inorganic world are controlled, he may not only vary the form of his analysis, almost at pleasure, making it more or less transcendental in many directions, but he may introduce factors or relations, apparently inconceivable in real existence, and then interpret them into results quite as real as those of the legitimate calculus with which he is working, but lying outside of its domain.

If biology can ever be developed in such manner that its results may be expressed in mathematical formulæ, it will be the pleasing task of the future analyst to ascertain the nature of the inconceivable (or imaginary as they are termed in mathematics) quantities which must be introduced when changes of form or structure take place. Such will be analytical morphology, in its proper sense; but it is a science of the future, and will require for its calculus a very complex algebra.

In the observation of the habits of inferior animals we recognize many complications of action, which, though directed to the accomplishment of definite purposes, we do not entirely comprehend. They are, in many instances, not the result of either the experience of the individual, or the education of its parents, who, in low forms of animals, frequently die before the hatching of the offspring. These actions have been grouped together, whether simple or complex, as directed by what we are pleased to call instinct, as opposed to reason. Yet there is every gradation between the two.

Among the various races of dogs, the companions of man for unnumbered centuries, we observe not only reasoning powers of a rather high order, but also distinct traces of moral sentiments similar to those possessed by our own race. I will give no examples, for many may be found in books with which you are familiar. Actions evincing the same mental attributes are also noticed in wild animals which have been tamed. You will reply that these qualities have been developed by human education; but not so, there must have been a latent capacity in the brain to receive the education and to manifest the results by the modification of the habits. Now it is because we are vertebrates, and the animals of which I have spoken are vertebrates, that we understand, though imperfectly, their mental processes, and can develop the powers that are otherwise latent. Could we comprehend them more fully we would find, and we do find from time to time in the progress of our inquiries, that what was classed with instinct is really intellection.

When we attempt to observe animals belonging to another sub-kingdom, Articulata, for instance, such cases as bees, ants, termites, etc., which are built upon a totally different plan of structure, having no organ in common with ourselves, the difficulty of interpreting their intellectual processes, if they perform any, is still greater. The purposes of their actions we can divine only by their results. But anything more exact than their knowledge of the objects within their scope, more ingenious than their methods of using those objects, more complex yet well devised than their social and political systems, it is impossible to conceive.

We are not warranted in assuming that these actions are instinctive, which, if performed by a vertebrate, we would call rational. Instead of concealing our ignorance under a word which thus used comes to mean nothing, let us rather admit the existence here of a rational power, not only inferior to ours, but also different.

Thus, proceeding from the highest forms in each type of animal life to the lower, and even down to the lowest, we may be prepared to advance the thesis that all animals are intelligent in proportion to the ability of their organization to manifest intelligence to us, or to each other; that wherever there is voluntary motion there is intelligence, obscure, it may be, not comprehended by us, but comprehended by the companions of the same low grade of structure.

However this may be, I do not intend to discuss the subject at present, but only wish, in connection with this train of thought, to offer two suggestions.

The first is that, by pursuing different courses of investigation in biology, we may be led to opposite results. Commencing with the simplest forms of animal life, or with the embryo of the higher animals, it may be very difficult to say at what point intelligence begins to manifest itself; our attention is concentrated, therefore, upon those functions which appear to be the result of purely mechanical arrangements, acted upon by external stimuli. The animal becomes to our perception an automaton, and, in fact, by exercising some of the nervous organs last developed in its growth, we can render an adult animal an automaton, capable of performing only those habitual actions to which its brain, when in perfect condition, had educated the muscles of voluntary motion. On the other hand, commencing with the highest group in each type, and going downward, either in structural complication, or in age of individual, it is impossible to fix the limit at which intelligence ceases to be apparent.

I have in this subject, as in that of tracing the past history of our insects, in the first part of this address, preferred the latter mode of investigation: taking those things which are nearest to us in time or structure, as a basis for the study of those more remote.

The second consideration is, since it is so difficult for us to understand the mental processes, whether rational or instinctive (I care not by what name they are called) of beings more or less similar, but inferior to ourselves, we should exercise great caution when we have occasion to speak of the designs of One who is infinitely greater. Let us give no place to the crude speculations of would-be teleologists, who are, indeed, in great part refuted already by the progress of science, which

continually exhibits to us higher and more beautiful relations between the phenomenon of nature "than it hath entered into the mind of man to conceive." Let not our vanity lead us to believe that because God has deigned to guide our steps a few paces on the road to truth, we are justified in speaking as if He had taken us into intimate companionship, and informed us of all His counsels.

If I have exposed my views on these subjects to you in an acceptable manner, you will perceive that in minds capable of receiving such impressions biology can indicate the existence of a creative or directive power, possessing attributes, some of which resemble our own, and controlling operations which we may feebly comprehend. Thus far natural theology, and no farther.

What then is the strict relation of natural history or biology to that great mass of learning and influence which is commonly called theology; and to that smaller mass of belief and action which is called religion?

Some express the relation very briefly, by saying that science and religion are opposed to each other. Others again that they have nothing in common. These expressions are true of certain classes of minds; but the greater number of thinking and educated persons see that though the ultimate truths taught by each are of quite distinct nature, and can by no means come in conflict, inasmuch as they have no point in common, yet so far as these truths are embodied in human language and manipulated by human interests, they have a common dominion over the soul of man. According to the method of their government, they may then come into collision, even as the temporal and spiritual sovereigns of Japan occasionally did, before the recent changes in that country.

In answering the query above proposed, it will be necessary to separate the essential truths of religion from the accessories of tradition, usage, and most of all, organizations and interpretations, which have, in the lapse of time, gathered around the primitive or revealed truth.

With the latter the scientific man must deal exactly like other men; he must take it, or reject it, according to his spiritual gifts, but he must not, whatever be his personal views, discuss it or assail it as a man of science, for within his domain of investigation it does not belong.

With regard to the accessories of traditions, interpretations, etc., our answer may be clearer when we have briefly reviewed some recent events in what has been written about as the Conflict of Religion and Science. Some centuries ago, great theological disgust was produced by the announcement that the sun and not the earth was the center of the planetary system.

A few decades ago profound dissatisfaction was shown that the evidence of organic life on the planet was very ancient. Recently some annoyance has been exhibited because human remains have been found in situations where they ought not to have been, according to popularly received interpretation: and yet more recently much apprehension has been felt at the possible derivation of man from some inferior organism; an hypothesis framed simply because in the present condition of intellectual advancement no other can be suggested.

Yet all these facts. but the last, which still is an opinion, have been accepted, after more or less bitter controversy on both sides, and the fountain of spiritual truth remains unclouded and undiminished. New interpretations for the sacred texts, supposed to be in conflict with the scientific facts, have been sought and found without difficulty. These much feared facts have, moreover, given some of the strongest and most convincing illustrations to modern exhortation and religious instruction.

Thus, then, we see that the influence of science upon religion has been beneficial. Scholastic interpretations, founded upon imperfect knowledge, or no knowledge, but mere guess, have been replaced by sound criticisms of the texts, and their exegesis in accordance with the times and circumstances for which they were written.

It must be conceded by fair minded men of both sides that these controversies were carried on at times with a rudeness of expression and bitterness of feeling now abhorrent to our usages. The intellectual wars of those days partook of the brutality of physical war, and the horrors of the latter, as you know, have been ameliorated only within a very few years.

I fear that the unhappy spirit of contention still survives, and that there are yet a few who fight for victory rather than for truth. The deceptive spirit of Voltaire still buds forth occasionally; he, who, as you remember, disputed the organic nature of fossil shells, because in those days of schoolmen their occurrence on mountains would be used by others as a proof of a universal Noachian deluge. The power of such spirits is fortunately gone for any potent influence for evil, gone with the equally obstructive influence of the scholastics with whom they formerly contended.

Since then there is no occasion for strict science and pure religion to be in conflict, how shall the peace be kept between them? By toleration and patience. Toleration toward those who believe less than we do, in the hope that they, by cultivation or inheritance of æsthetic perception, will be prepared to accept something more than matter and energy in the universe, and to believe that vitality is not altogether undirected colloid chemistry.

Toleration also toward those who, on what we think misunderstood or insufficient evidence demand more than we are prepared to admit, in the hope that they will revise additional texts which seem to conflict, or may hereafter conflict, with facts deduced from actual study of nature, and thus prepare their minds for the reception of such truths as may be discovered, without embittered discussions.

Patience, too, must be counseled, for much delay will ensue before this desired result is arrived at; patience under attack, patience under misrepresentation, but never controversy.

Thus will be hastened the time when the glorious, all-sufficient spiritual light, which though given through another race, we have adopted as our own, shall shine with its pristine purity, freed from the incrustations with which it has been obscured by the vanity of partial knowledge and the temporary contrivances of human polity.

So, too, by freely extended scientific culture, may we hope that the infinitely thicker and grosser superstitions and corruptions will be removed, which greater age and more despotic governments have accumulated around the less brilliant though important religions of our Asiatic Aryan relatives. These accretions being destroyed, the principal difficulty to the reception by those nations of higher spiritual truths will be obviated, and the intelligent Hindoo or Persian will not be tardy in recognizing, in the pure life and elevated doctrine of the sincere Christian, an addition to and fuller expression of religious precepts with which he is familiar. In this manner alone may be realized the hope of the philosopher, the dream of the poet, and the expectation of the theologian—a universal science, and a universal religion, co-operating harmoniously for the perfection of man and the glory of his Creator.

ART. XXXIV.—*On the Temperature attainable by Rock-crushing, and its Consequences;** by ROBERT MALLET, F.R.S.

IN developing the theory of volcanic heat and energy embraced in his paper "On the Nature and Origin of Volcanic Heat and Energy" (Phil. Trans., Part I, 1873), the main object of the author was to prove that the annual work of secular contraction in our globe, when transformed into heat, was more than adequate for the supply of volcanic activity existing upon our planet. While indicating generally the circumstances which must attend as results of the descent of the exterior shell

* From the Philosophical Magazine for July, 1875.

upon the more rapidly contracting nucleus, it was not necessary to his argument to follow into detail the mechanism of local dislocation and crushing due to such descent. Nor would the limits of his paper admit of his entering into much detail as to the circumstances attending subterranean dislocation and crushing of rocky matter, or pointing out how some of these must greatly tend to exalt the temperatures due to the transformation of the mechanical work locally done. It was necessary to a truthful examination of the question whether or not the annual supply of heat transformed from the work of secular contraction were sufficient to meet the demands of existing volcanic action, that he should not overrate the work so transformed; and accordingly, in determining by experiment a measure for the amount of that work, the author viewed the work of crushing of unconfined or unsupported masses alone as the source of heat, this method being that only which could afford perfectly trustworthy experimental results. He paid no regard to the additional work that must attend the collision and friction of already crushed masses in the further progress of their deformation and forced transport to points more or less distant from those at which the crushing had taken place. The work of crushing in free air was capable of rigid determination; the work of subsequent deformation and transportation can only admit of estimation upon assumed data, and these necessarily of a somewhat arbitrary character, seeing how little we know accurately of the nature and disposition of the rocky materials of our earth's crust, except at the most inconsiderable depths from its surface. Nor were any of the circumstances pointed out by which high temperatures are capable of being attained locally in rocky masses crushed beneath our surface and which we must assume as those actually occurring in nature. The writer's object here is to point out, 1st, that, taking the annual supply of heat from transformed work of contraction, by experiment in the way he has done, the result, though more than sufficient to sustain his theory, affords alone no complete measure of the highest temperature that may through its means be locally developed; 2ndly, to answer some doubts which have been raised as to whether the temperature to which subterranean rocky masses can become raised by the heat evolved in their crushing and transportation of particles can be sufficient to bring more or less of these at such foci of crushing and dislocation to the fusing-point of such materials, which the author in his original paper assumes to be 2000° Fahr.

Professor Hilgard, occupying the chair of geology in the University of Michigan, U. S., in an able paper published in

the American Journal of Science, vol. vii, June, 1874,* has, in terms as clear as they are courteous, pointed out the *lacunæ* in the author's original paper in the following passage:—

"One point, however, must strike every reader of the original memoir, viz: the preëminence given by Mallet to the *crushing of solid* rock as the means of producing heat and fusion. One would naturally look to the results of his experiments on this subject for the proof of the efficiency of this agency. But we find that the maximum *temperature* resulting from the crushing to powder of the hardest rock is something over 217° Fahr. This, then, represents the maximum increment of temperature that can be rendered efficient toward the fusing of rocks by the crushing process under the most favorable circumstances, viz: upon the supposition that it takes place instantaneously, or under such circumstances that the heat cannot be conducted away, and, further, that the resistance of the rock has not been materially diminished by the downward increase of hypogeal temperature. At the most moderate depths at which volcanic phenomena can be supposed to originate the last-mentioned factor must exert a very considerable influence, reducing materially the available heat-increment. Hence the numerical results of Mallet's laborious experiments on rock-crushing, however interesting and useful as affording a definite measure of the thermal effects producible by this means, yet fail to carry conviction as to the efficacy of this particular *modus operandi* in reducing large masses of solid rock to fusion, unless essentially supplemented by friction, not so much of rock walls against each other, but more probably by the heat produced within more or less comminuted *detrital* or *igneoplastic* masses by violent pressure and deformation.

"It may be doubtful what would be the physical and thermal effect of enormously great pressure upon rock powder such as was produced in Mallet's experiments; but it would seem that if *made* to yield, the frictional effect must produce very high temperatures. *A fortiori*, solid detrital masses of variously sized fragments intermingled (such as, rather than powder, would be likely to result from steady pressure), yielding rapidly under great pressures, might, under the *combined influence of friction and rock-crushing*, well be supposed to reach the temperature of fusion, which a simple crushing of a solid mass by pressure would have failed to produce. Mallet mentions the probable influence of friction and of the squeezing of igneoplastic masses, but does not attach to these agencies such importance as they seem to me to deserve.

"Of the complex thermal effects of the movements of

* Phil. Mag., July, 1874, p. 41

detrital masses under great pressure Mallet's figures of course offer no measure whatsoever; nor is this, or even the thermal coefficients resulting from his rock-crushing experiments, at all necessary to the establishment of the postulates of his theory."

Subsequently the Rev. O. Fisher, in a paper read before the Geological Society of London, May 12, 1875, entitled "Remarks upon Mr. Mallet's Theory of Volcanic Energy," has repeated the observations of Professor Hilgard, and extended his objections to the author's theory in general in a way which appears not warranted. It will be sufficient here to quote the following from Mr. Fisher's paper:—"Indeed the form in which the objection to Mr. Mallet's reasoning suggested itself to my mind on first reading his paper was simply this. If crushing the rocks can induce fusion, then the cubes experimented upon ought to have been fused in the crushing; and I still adhere to this simple mode of expressing my objection." Again:—"He considers that the heat so developed may be localized, and that the heat so developed by crushing, say 10 cubic miles of rock, may fuse 1 cubic mile. But I ask why so? The work is equally distributed throughout; why should not the least be so also? Or if not, what determines the localization? For example, suppose a horizontal column 10 miles in length and 1 in sectional area to be crushed by pressure applied at its ends, which of the 10 cubic miles is the one to be fused? But if no cause can assign one more than another, it is clear that they will all be heated by 170° and none of them fused."

If a cube of rock, which in free air is found to crush under a certain pressure, be imagined situated deep within a mass of similar rocks and there crushed, it does not admit of dispute that the work necessary to effect crushing must be largely increased; the particles of the cube and the entire mass of surrounding rocks are under the insistent pressure of the superincumbent rock in a state of elastic equilibrium. It follows, therefore, that the pressures of the surrounding rock produce the same effect upon the cube as regards resistance to crushing as if they were cohesive forces acting within the cube; and the work necessary to crush the cube by its finally giving way, in whatever direction this *encastrement* by pressure may be least, will be increased over that which would crush it in free air nearly in the ratio in which the imaginary cube is exposed to external pressure greater than that in air. Thus, if the cube of Guernsey granite (No. 12, Table I, Phil. Trans., part 1, 1873, p. 186) which required 4,336,712 lbs. per square foot to crush it in air, equivalent to a superincumbent column of the same rock of the mean specific gravity 2·858, or weighing 178·3392 lbs. per cubic foot, be supposed situated at a depth of ten to

twenty statute miles, it will require rather more than 2·14, or, at twenty miles, 4·28 times as much pressure upon two opposite faces to crush it that it did when in air; and if we assume the displacement of the crushed particles after crushing to be the same as in the case of the cube crushed in air, then the work and the heat due to its transformation will be also 2·14, or 4·28 times as great. And, as in the case of the cube crushed in air the heat developed was sufficient to fuse at (at 2000° Fahr.) 0·108 of its own volume, or, in other words, the crushing of 10 cubic feet of the rock would be required to raise to that point one cubic foot, then in the case of the imaginary cube situated at the depth of ten miles enough heat would be evolved by the work of crushing each cubic foot to fuse 0·231 cubic foot, or, at twenty miles, to fuse 0·462 cubic foot of the same rock, or nearly half the volume crushed,—and this assuming that the initial temperature of the rock at 10 or 20 miles depth was only 57° Fahr. as in the author's experiments, instead of from 500° to 1000° Fahr. or more as it may be at 10 to 20 miles depth. Therefore, under the pressure due to a depth of 20 miles and an initial temperature of 1000° Fahr., the heat developed by the work of crushing each cubic foot of rock will be sufficient to fuse its own volume. Thus also if we assume the fusing-point of the rocks not to be 2000° Fahr., as indicated by the author's experiments on the cooling of slags, but considerably higher, say 2500° or more, we have still a sufficient supply of heat due to crushing alone to bring 0·8 of the entire volume to the fusing-point.

These considerations, apart from all others yet to be adverted to, appear fully sufficient to refute the Rev. O. Fisher's first objection above quoted; indeed the statement that if under any circumstances and in the rock-masses of nature "crushing can induce fusion, then the cubes experimented upon ought to have been fused in the crushing," seems as unsupportable as it would be to affirm that no heat is developed by the slow oxidation (*eremacausis*) into water and carbonic acid of a pound of wood, which when burned develops a well-known amount of heat.

The depths above assumed do not widely differ from those at which the foci of earthquakes have been found by the author (Report on Neapolitan Earthquake) in 1857, and by others since that time, and which may be presumed to indicate in some degree the possible depth of volcanic activity.

The writer now proceeds to reply to the second objection of the Rev. O. Fisher as above quoted, which appears to him based entirely on a misconception of the physical conditions involved. Let us consider what will happen in the case of a prism or column of rock crushed against the face of an unyield-

ing mass. If the prismatic mass be not homogeneous throughout, crushing will commence at the weakest place; if it be perfectly homogeneous, crushing will commence and continue where the prism is in contact with a fixed mass, and that whether the prism be crushed at one or both ends—because it is at such surface of contact that the compression of the particles of the prism is greatest, and where therefore the elastic limit of their cohesion is first and successively overpassed. This may be seen illustrated in the stonework of buildings the material of which is overloaded, where crushing or spalling off of the ashlar stones only occurs at and near the joint.* In either case, whether the prism be homogeneous or not, the crushing must be localized either to the end or ends of the prism, or to the plane of weakness where it first yields, and which then becomes the crushing surfaces of two opposed prisms. It is these physical conditions which "determine the localization" of crushing in the prism, and which conditions have been disregarded in the Rev. O. Fisher's objection. Let us now consider the subsequent effects of the successive crushing of a column of prismatic mass of rock, one extremity of which is continually urged against the face of a fixed mass of rock which does not yield, a case which approximates to that which most frequently occurs in nature, and which, to fix our ideas, we may suppose presents a face for crushing one square foot; and being continually urged forward, and the pressure being greatest where the pressing column comes into contact with the fixed mass of rock, the extremity of the column supposed homogeneous, or the parts adjacent thereto, are continually crushed by a succession of *per saltum* movements. The first cubic foot of the column that is crushed has its temperature raised, let us suppose, by the minimum of 217°. The crushed fragments at this temperature are pushed aside by the advancing column, whose extremity is thus surrounded by crushed materials at a temperature of 217°, and the second foot in length of the column becomes crushed. But the material of this second cubic foot is at a higher temperature before it is crushed than was the first cubic foot; so that the heat due to the transformed work of crushing of each successive cubic foot of rock raises its temperature to a higher point than that of the preceding one, because each successive cubic foot at the instant before crushing is at a temperature already higher than the preceding ones, resulting from the heat taken up by the uncrushed column from the hotter portions of material surrounding it that have already been heated by

* See also E. Hodgkinson's experiments on the directions of fracture of crushed material, Brit. Assoc. Report, vol. vi; and Tredgold on Cast Iron, by Hodgkinson, part 2, p. 319, and plate 1.

crushing; so that, if T be the temperature produced in the first cubic foot crushed, and t be the temperature of the crushed material which communicates a portion of its heat to the next cubic foot crushed, the temperatures of successive cubic feet crushed may be illustrated by some such series as the following:—

Cubic foot crushed.		
No. I.	No. II.	No. III.
T	$T+\frac{t}{n}$	$T+\frac{t}{n}+\frac{t}{m}$ . . . &c.

We have here supposed the column crushed at atmospheric pressure; but if crushed under an insistent column of 20 miles, then the temperature T would be 4·28 times 217° = 928°, and the subsequent temperatures correspondingly increased.

No limit arises to this continual augmentation of temperature while the rock retains its rigidity: after that has been seriously impaired or lost, any further exaltation of temperature apart from the detrusion or transport of fragmentary matter, as hereafter referred to, becomes dependent upon the deformation and detrusion of a more or less plastic mass. It is well ascertained, however, by observation on a great scale, that granite remains rigid at a temperature nearly approaching the softening point of cast iron;* so that a large range of rigidity must exist for the exaltation of its temperature in the way above suggested; and in the state of aggregation which we are warranted in supposing rocky masses to exist in at considerable depths, it is probable that this range of rigidity would be even further extended than in the case of granites found at or near the present surface of our globe.

There is a close analogy between the conditions of gradual exaltation of temperature above sketched, and those by which aërolites, flying at an immense velocity through our atmosphere, are heated from the temperature of the stellar spaces to that of incandescence or even fusion of those bodies. The aërolite, which, according to Schiaparelli, may in some instances be forced through our atmosphere with a relative velocity exceeding 3500 feet per second (one enormously exceeding that at which air can rush into a vacuum), compresses the stratum of air immediately in advance in almost the same manner as if at the first instant of contact the air were a rigid body. The temperature developed is greater as the velocity of compression is so, and as the volume

* The observations upon which these statements are founded have been made after various great conflagrations of stores or warehouses at London, Liverpool, and Dublin, into the construction of which granite blocks and cast iron in columns, girders, &c., largely entered. The cast iron was either melted or softened to the consistence of soap; the granite heated to like temperature, except being split in various directions, was found unaltered, except more or less in color, after having been again cooled.

ompressed is less; the most highly heated air is therefore the ratum directly in contact at any instant with the stone; and ie latter licks up more or less of the heat as it passes through succession of such compressed strata, and so receives continual ccessions of heat until the temperature of the meteoric stone self reaches the limit given by that of the stratum of compressed ir in immediate contact with it at any instant. If a body as iobile and compressible as air can thus by sufficiently rapid ompression be raised above the temperature of incandescence, e may readily conceive how great an exaltation of temperature iay be produced in the rigid materials of our earth's crust hen exposed to a pressure which may be viewed as limitless i reference to the resistance opposed to it, and which, in conequence of the conditions of elastic resilience hereafter referred), may give rise to motion and crushing with velocities even xceeding those with which aërolites traverse our atmosphere.

The well-known experiment of cutting a hard steel file in two y the rapid rotation of a thin disk of soft sheet iron pressed gainst it is another example. The heat developed at the workig-point, so far as it is communicated to the disk, is rapidly irried off and dissipated by its rotation, and it thus remains ool enough to be touched by the hand, although the heat deeloped by it and accumulated at and near the working-point i the file is sufficient to raise that to the temperature at which ast steel becomes softened and approaches fusion.

The cutting of steel railway bars across when at a very low ed heat by a rapidly revolving circular saw, which revolves artially immersed in cold water, and from whose action a torent of incandescent fragments of steel is discharged, is a like ase.

Besides the heat transformed from the work of compression nd crushing, a large amount of heat must also be generally roduced by transformation of the work expended in friction nd detrusion. No experiments have as yet, to the author's nowledge, been made upon the amount of heat developable in agmentary pulverulent masses, such as sand, by the forcible ansposition of more or less of the particles; nor do we know ith certainty the conditions under which external mechanical ressure is transmitted through sand or like discontinuous mater. As in rigid solids exposed to unequal mechanical pressures nere exist planes or surfaces within the mass such as have een denominated by Moseley "planes of easiest shearing," or liding, so in masses of pulverulent matter, whatever be the hape or size of the particles, provided these be small in relation the whole mass, and their mutual adhesion (if any) small also, ich planes must by unequal mechanical pressure be brought ito existence. Along any such plane we may imagine the

sand or other pulverulent matter forced to move over itself in opposite directions at opposite sides of the plane; that is to say, we may suppose the sand forced along such a plane much in the same way that a mass of sandstone or of granite would be forced along such a shearing plane as had been produced in it previously by mechanical pressure. If this reasoning be admitted, we must suppose that heat would be developed along such a plane and at short distances from it in a way more or less analogous to that produced by forcing one rough surface of stone over another. What the coefficient of friction in this case would be can only be determined by experiment; but we may justifiably conclude that the amount of friction per unit of surface would increase proportionately to the pressure applied externally to the entire mass—exposed to more or less of which, motion at any such surface of friction must take place. Coulomb, Morin, and others have found the friction of some sorts of rough stone upon other rough stone to reach as much as three-fourths the pressure; and should this coefficient increase proportionately under the enormous pressures to which a discontinuous mass at several miles depth may be subjected, we can readily see that the transformed heat of friction produced by internal movements taking place in such materials after crushing has occurred, must be the source of a large amount of heat over and above that originally due to the crushing itself. Thus, for example, if we assume a surface of such disintegrated material sliding over a similar surface, or over a rough surface of coherent rock, and under the pressure of ten miles of rock of the specific gravity of granite, at the rate of one foot per second, and if we take the coefficient of friction as low as 0·5, we have 4,326,600 foot-pounds of frictional work per second, which, divided by J (=772), gives 5604 units of heat evolved per second from each square foot of surface, and to this development there is no limit while the circumstances continue the same, except that of the distance that one surface is forced over the other. And great as is this evolution of heat under such enormous pressures, it would be further increased in the event of the fragmentary particles being heated so as to present incipient viscosity of surface and more or less of mutual agglutination.

Temperature with respect to any given solid material is dependent upon the units of heat present in a unit of mass or of volume of the substance. If for the same total heat we diminish the mass or volume, the temperature is proportionately increased. When the material is surrounded by matter capable of carrying off heat by conduction, or evection, or radiation, and the heat is evolved within the mass by work done upon it, then another condition, that of time, has to be taken into account: for the shorter the time within which a given amount of

heat due to transformation of work is evolved within the unit of mass, the less of that total is dissipated by conduction, &c.

A familiar example of this is every day seen in the light and heat elicited by abrasive friction, or collision between hard bodies. When two lumps of granite or other hard stone are struck together, heat and light are instantly evolved at the small surface of contact, where the material of one or both masses is crushed. The work done may be but that of the crushing of a fraction of a grain of the stone; but it is great in reference to the extremely brief instant of time during which the work is performed: the crushed particles are raised to a temperature of luminosity for a brief moment because there is not time for the surrounding surfaces of the cold stone to carry off the heat evolved by conduction, though the dissipation of heat thus produced is such that the luminosity again instantly disappears. The temperature at the crushing-point is greater as the work done in a unit of time and upon a given weight of the material is greater. That the temperature capable of being thus produced approaches that of the fusing-point of steel, is of a gun-lock by the flint. In the case of small masses of rock, evident from the phenomenon of a spark struck from the steel such as the 1½-inch cubes of the author's experiments, crushed between two opposite surfaces of steel, the actual temperature of the crushed particles can never be found to reach that due to the work of crushing; for the heat of relatively small mass of the crushed cube in close contact with far larger masses of cold steel of high conductivity is carried off almost as fast as it is evolved; and as the total amount of heat evolved from the crushing of such a cube of the hardest rock experimented upon by the author (namely, number 12, Table I, Phil. Trans., part 1, 1873, p. 186) could raise its own mass only through 217°, if the temperature of fusion of the rock may be taken at 2000°, it is obvious that such a cube could not be fused by the work of crushing alone, even though all the heat due to the crushing work remained in the cube, none being dissipated to surrounding objects.

In the case of a cube such as this losing heat by dissipation, the temperature of the crushed mass depends upon the time in which the work of crushing is done. In the author's experiments the crushing of each cube in column 12 occupied a mean time somewhat greater than that in which a heavy body could fall freely through a space of 0·09 foot (No. 12, Table I. *l. c.*, col. 19)—that is, 0·075 of a second; for more rapidly than that the crushing surfaces could not approach each other. If, however, the conditions had been such that but $\frac{1}{n}$th the above time were expended in the crushing, then a proportionately less quantity

of the heat evolved would have been dissipated; and this, we shall see further on, must be the case in nature. When two rock-surfaces are urged against each other in the shell of our globe by the gradual withdrawal of support by contraction of the nucleus, the rocky masses for great distances from the opposed surfaces are brought into a state of elastic compression, gradually increasing up to the crushing-point somewhere, when a greater or less portion of rock suddenly gives way by crushing and is more or less removed by detrusion in some lateral direction. The material of the rock for a greater or less distance from the crushing-point is therefore in the condition of a compressed spring which is suddenly released. When so released, the velocity of resilience depends principally upon the modulus of elasticity of the rock; and the velocity of release of the spring, which is that with which the crushing is performed, is extremely great in the case of hard granite or generally similar homogeneous rock, in which it probably exceeds 10,000 feet per second, though in very much less-elastic rocks falling considerably short of this.* But had the rock-specimen crushed in the author's experiments been a cubic foot in place of an inch and a half cube, the time of crushing must have been *greater* than ·249 second (or nearly a quarter of a second), or the crushing would have been performed with nearly a velocity of 2 feet per second, and that would be less than $\frac{1}{5000}$ of the velocity with which the same would have been crushed if circumstanced as in the shell of our globe. And if we extend our view from the crushing of a cubic foot or two to that of a cubic mile or more, we see that there would be very little of the total heat evolved lost by dissipation, there being scarcely any time in which that could occur, the possible rate of crushing of a cubic mile being less than half a second.

In the case of a very large mass of rock crushed simultaneously, or nearly so, as every portion of the rock evolves heat proportionate to the crushing-work done upon it, so the heated portions of crushed material situated near the exterior of the entire mass act as "*jacketing*," so as to preserve the deeper-seated portions of the heated mass almost absolutely from any dissipation of heat for a considerable length of time, that time depending, *cæteris paribus*, on the conductivity of the crushed material and the difference in temperature between the crushed material and the uncrushed rock adjacent to it. There are some experimental grounds for concluding that the absolute crushing-force per unit of volume in any given rock increases as the absolute volume of the mass simultaneously crushed becomes greater; thus it has been found by Rondelet that large cubes of stone required a proportionately larger crushing-force than

* See the author's "Earthquake-wave Experiments," Phil. Trans., 1862, vol. clii.

ıaller ones; much stress, however, cannot be laid upon this, we cannot assume with any certainty what are the precise nditions under which rock-surfaces in our earth's shell are rced together, and the distribution of the crushing-pressure ay be indefinitely varied.

In the author's experiments the cubes crushed by pressure on ro opposite faces were free upon the other four; it cannot be oubted that, had only two opposite faces been free and the essure applied simultaneously upon the four other faces, two ıd two respectively, the pressure necessary for crushing or the ork thereof would have been considerably increased. Further, none of the faces were free, and all those except the two pposite faces to which the crushing pressure is supposed applied, ıd the motion outwards of any of their particles opposed by ı initial pressure, such as that of an insistent mass of rock, ıe work to be done to produce crushing would be necessarily creased by the amount required to overcome such initial essure, as has been already pointed out.

Another and further source of heat arises after crushing and etrusion of the fragmentary matter, and after the latter has rived at a temperature at which the fragments have become ore or less viscous and adherent by reason of the further work cpended in the deformation and detrusion by forcing forward ırough highly irregular or constricted rock-channels of the ated and now viscous mass. There do not exist at present ıfficient data by which to calculate the amount of work necesry to a given amount of deformation in viscous masses; and ence we cannot calculate the amount of heat that in nature ight arise from it. Hirn, however, has shown that in the case plastic bodies, such as lead, the heat developed is proporonate to the work done in deformation; so that, if we knew ıe pressure per unit of surface necessary to produce a certain eformation in an already heated mass of given viscosity, we ould calculate how much its temperature would be exalted y the work of the assigned deformation.

Examples, however, are not wanting which prove that a very rge exaltation of temperature can thus be produced—as, for cample, in the old-fashioned method by which blacksmiths ere accustomed to light their fires. A thin square rod of very ood tough iron was hammered at its extremity by a succession f rapidly given blows from a light hand-hammer. After a ıinute or so the rod, for the portion of its length hammered at ıe extremity, became red, and in a second or two more of istortion of its form by continuance of the hammering, the on could be made nearly white hot.

A similar example, on a much larger scale, occurs in the proess of rolling iron or steel. When a heavy billet of iron or

steel, heated to a brilliant yellow heat, is passed between the rolls of the iron mill, and the massive lump is rapidly elongated into a bar, its temperature, notwithstanding that it is rapidly and constantly losing heat by radiation and evection, is observed visibly to increase, so that the mass becomes at a certain stage white or welding hot by the transformation into heat of the work of deformation so rapidly and powerfully applied to it.

The action of the machine employed in the arsenal at Woolwich for making lead rods to be afterward pressed into bullets affords another striking example. In this machine a cylindric block of lead, maintained at a temperature of 400° Fahr., is by a steady pressure upon the end, which is 8″·5 in diameter, of 16,700 lbs. per square inch of its surface, forced through an aperture at the other extremity into a rod of 0″·525 diameter, at such a rate that five inches in length of the cylindric block becomes a rod of about 100 feet in length of the above diameter per minute. We have thus 393,906 foot-pounds of work done upon the lead per minute, dividing which by J we have 510·2 British units of heat developed per minute from the transformed work. In the actual machine the whole of this is ultimately dissipated and lost; but if none of it were dissipated, as the cylindric block of lead of 8·5 in. diameter by 0·416 ft. (5 inches) weighs 116·3 lbs., and the specific heat of lead is =0·029 (or perhaps a little more at 400° Fahr.), it follows that the heat developed by its deformation from the short cylindric block of 5 inches length to a rod of about 100 feet length, is enough to raise the temperature of the lead through 151° Fahr., or, were no heat lost, to raise its temperature from 400° to 551° or thereabouts—that is, within about 50° of its melting point. If, therefore, we could by a reverse process squeeze the 100-foot rod back into the original block of 8″·5×5″, we should find the lead in the latter not only liquid, but considerably above its temperatue of fusion, or at nearly 700° Fahr. It is obvious, therefore, that any viscous or plastic body such as lava, continually forced through apertures varying in area and form and suffering continual deformation, as when forced through a volcanic tube or vent, must have its temperature continually exalted so long as it continues thus to be urged forcibly forward, assuming, as is very nearly the truth in nature, that an extremely small proportion of the heat developed in the process can be dissipated by conduction to the walls of the tube.

The preceding remarks appear to the writer sufficient to show that there is no physical difficulty in the conception involved in his original memoir (Phil. Trans. 1873), but not there enlarged upon in detail, that the temperatures consequent upon crushing the materials of our earth's crust are sufficient locally to bring these into fusion.

ART. XXXV.—SIR CHARLES LYELL.

No European geologist was so well known, personally, in he United States as Lyell. His two visits to this country, in 841 and 1845, recorded in four volumes of travel characterzed by great good judgment, large mindedness and catholicity, nade his name familiar throughout the land, and gave a degree f popularity here to his philosophical and technical writings vhich they would otherwise have hardly obtained.

Called by Mr. Lowell to Boston in 1841 to deliver a course f twelve lectures on Geology before the "Lowell Institute," yell was the first European, of eminence in science, who ppeared upon the platform as a lecturer before an American udience. That his lectures were highly esteemed is well known, nd it was a sufficient evidence of this that he was again nvited to Boston on a like commission in 1845–6, and before he same institution. The personal relations and friendships ommenced on these occasions endured to the end, and were endered doubly interesting by the charm shed over every ocial relation by Lady Lyell, who won universal esteem by hose qualities of manner which were less prominent in her often abstracted husband. The following familiar private letter from the late Dr. Mantell, written in 1841 to Prof. Silliman (the elder), gives a vivid sketch of Lyell as he appeared to his scientific associates at the time of his first visit to the United States. As all the parties named in this letter are now passed away there can be no objection to its reproduction in this connection.

"LONDON, *June* 14th, 1841.

"MY VERY DEAR FRIEND:

"I was about to write you to inform you of Mr. Lyell's intentions which he communicated to me but a short time since. I dined with him last week—a farewell party. His charming little wife, a daughter of Mr. Leonard Horner, accompanies him. I have said so much of you and yours to her that she is quite anxious to visit New Haven; if she does I am sure you will be delighted with her. And now for a strictly private sketch of my old friend. About twenty years or more ago, one beautiful summer evening, a young Scotchman called at Castle Place (Lewes*) and announced himself as Mr. Lyell, stating that he was fond of geology, had been attending Jameson's lectures at Edinburgh, and had visited his former Alma Mater, Midhurst Grammar School, in the west of Sussex; and that, while rambling about the

* Mantell's place of residence at that time.

neighborhood, he found some laborers quarrying in stone which they called whin. As this term is *Scoticé* trap, the young traveler was much puzzled to know how such a rock appeared in the south of England, and upon inquiry of one of the laborers why the stone was so called, the man referred him to 'a monstrous clever mon as lived at Lewes, a doctor who knowed all about them things and got curiosities out of the chalk pits to make physic with.' The man, in short, had been formerly a Lewes quarryman, and one of my collectors. Mr. Lyell being alone and on horseback and having nothing better to do, rode gently over the South Down, some twenty-five miles, and at the close of the day found himself at my residence. We were mutually pleased with each other, my few drawers of fossils were soon looked over, but we were in gossip until morning, and then commenced a friendship which has continued till now.

Mr. Lyell was educated for the bar. He practiced on the western circuit seven or eight years, and he allowed me to correspond with him only during the vacations. His father, who is a Scotch Laird, is still living, and there are several sons and daughters. Mr. Lyell is the eldest, and at the death of the father inherits the family estate, which, I believe, is moderate. However, about seven or eight years after our acquaintance, Mr. Lyell with great good sense, abandoned his profession, with his father's consent, and devoted himself wholly to geology, content with a moderate income, and living in a very unostentatious manner in an unfashionable part of the city. A few years ago he married Miss Horner, who is much younger than himself (Lyell is 45 or 46), and a more suitable companion he could not have found. He has no children. In person, Lyell presents nothing remarkable except a broad expanse of forehead. He is of the middle size, a decided Scottish physiognomy, small eyes, fine chin and a rather proud or reserved expression of countenance. He is very absent, and a slow but profound thinker. He was Professor in King's College, London, and gave lectures there and at the Royal Institution, but it so happened that I never heard him lecture. He always takes part in the discussions at the meetings of the Geological Society, but he has not facility in speaking; there is hesitation in his manner, and his voice is neither powerful nor melodious, nor is his action at all imposing. As a popular lecturer he would stand no chance with Buckland or Sedgwick. He is providing himself with very beautiful illustrations for his lectures at Boston; and I should suppose the prestige of his name and his European reputation will insure him a flattering reception. * * * * There is a hauteur or reserve about Mr. Lyell to strangers that prevents his being

popular among our society as he deserves to be. I believe
n to have an excellent heart, and he is very kind and affec-
nate when his better feelings are called upon." * * * *

This criticism of Lyell's style and manner as a public speaker
is certainly well founded, as all will agree who ever heard him
ture. But despite all infelicities, so great was the value and
hness of his matter, that he commanded the most respectful
d interested attention from his auditors. The reader of his
Principles" could not fail, however, to be struck with the fact
at the classic elegance of Lyell's style, for which his more
portant productions are so justly celebrated, must have been
e result of much labor.

We cite from the Geological Magazine edited by Henry
oodward, F. R. S., the following notice of his life and
oors. A more elaborate memoir may be expected in the
xt annual address of the President of the Geological Society
London.

"On Monday, the 22d of February, at his residence in Harley
reet, and in his seventy-eighth year, Sir Charles Lyell, after a
ng life of scientific labor, passed peacefully from amongst
, to his honored rest.

"To the outside world it may seem strange that the death of
man who was neither statesman, soldier, nor public orator,
ould arouse our sympathies so strongly, or that he should be
highly esteemed all over the world; but geologists know
ll what Lyell has done for them since he published the first
lume of 'The Principles of Geology' in 1830.

"It is in the character of historian and philosophical expo-
nt of geological thought that Lyell has achieved so much for
r science: nor can we fail to remember that those clear and
vanced views, for which he became so justly celebrated,
re advocated by him forty-five years ago, at a time when
ientific thought was still greatly trammelled by a strong re-
gious bias, and men did not dare to openly avow their belief
geological discoveries nor accept the only deduction which
uld be drawn from them.

"Born at Kinnordy, his father's seat near Kerriemuir, in
rfarshire, on the 14th of November, 1797, Lyell received his
rly education at a private school at Midhurst, and completed
at Exeter College, Oxford, where he took his Bachelor's
gree in 1819, obtaining a second-class in Classical honors in
ster Term. On leaving the University, he studied for the
r, but never practised that profession, his tastes having been
l by Dr. Buckland's lectures to the study of geology as a
ience. In 1824 he was elected an Honorary Secretary of the
ological Society of London, of which he was one of the ear-

liest Fellows. On the opening of King's College, London, a few years later, he was appointed its first Professor of Geology. He had already contributed some important papers to the 'Transactions' of the Geological Society, including one 'On a Recent Formation of Freshwater Limestone in Forfarshire, and on some Recent Deposits of Freshwater Marl, with a comparison of recent with ancient Freshwater Formations, and an Appendix on *Gyrogonites*, or Seed-Vessels of Chara;' also one 'On the Strata of the Plastic Clay Formation exhibited in the Cliffs between Christchurch Head, Hampshire, and Studland Bay, Dorsetshire;' another 'On the Freshwater Strata of Hordwell Cliff, Beacon Cliff, and Barton Cliff, Hampshire;' and an elaborate paper on the 'Belgian Tertiaries.' In 1827 he contributed to the *Quarterly* a review of Mr. Poulett Scrope's 'Geology of Central France' (the perusal of which is said first to have stimulated him to prepare and publish 'The Principles of Geology' on which his reputation as a philosophical writer mainly rests). These lesser works all showed a power of observation and of generalization which prepared the learned world for some greater and more important treatise from his pen, which should deal, not with local details, but with the general principles of the science. Nor were they disappointed when his *magnum opus*, 'The Principles of Geology,' appeared in three successive instalments, published respectively in 1830, 1832, and 1833. The work, subsequently enlarged into two volumes, has passed through numerous editions, and is still in as much demand as ever among students of the science. The work was subsequently divided into two parts, which have been published as distinct books, viz. 'The Principles of Geology, or the Modern Changes of the Earth and its Inhabitants, as illustrative of Geology,' and secondly, 'The Elements of Geology, or the Ancient Changes of the Earth and its Inhabitants, as illustrated by its Geological Monuments.' The substance of the last-named work has also been published under the title of 'The Manual of Elementary Geology,' a French translation of which was issued under the auspices of the famous Arago.

"Already, some time previous to the publication of this work, Mr. Lyell had been chosen a Vice-President of the Geological Society; and in 1828 he had undertaken a journey into the volcanic regions of Central France, visiting Auvergne, Cantal, and Velay, and continuing his journey to Italy and Sicily. He published the results of this expedition in the 'Edinburgh Philosophical Transactions,' and also in the 'Annales des Sciences Naturelles.'

"It was, however, the publication of his 'Principles of Geology' that gave him that established reputation which he

ever since continued to enjoy. 'Which of us,' asked Prof. Huxley, in his Anniversary Address to the Geological Society in 1869, 'has not thumbed every page of the "Principles of Geology?"' And he adds, 'I think that he who writes fairly the history of his own progress in geological thought will not easily be able to separate his debt to Hutton from his obligations to Lyell.' This cordial testimony of a fellow-laborer in the cause of scientific enlightenment exactly indicates Sir Charles Lyell's place in the history of that task. He was a man of singularly open mind, one of those who stand above their contemporaries and hail the dawn of new truths upon the world. His own works mark the progress of his own as well as of the public opinion on the great problems raised by scientific discovery, and he remained to the end of his life always ready for the reception of new facts, and for the corresponding modifications of opinion.

"Sir Charles Lyell had traveled and seen much. Thus in early manhood he explored many parts of Norway, Sweden, Belgium, Switzerland, Germany, and Spain, including the volcanic regions of Catalonia. In 1836 he visited the Danish Islands of Seeland and Monen, to examine their Cretaceous and Tertiary strata. In 1841 he was induced to cross the Atlantic, partly in order to deliver a course of lectures on his favorite science at Boston, and partly in order to make observations on the structure and formation of the Transatlantic Continent. He remained in the United States for a year, traveling over the Northern and Central States, and extending his journey as far southward as Carolina, and northward to Canada and Nova Scotia, his exploration ranging from the basin of the St. Lawrence to the mouths of the Mississippi. On returning from this journey, he published his 'Travels in North America,' a work of considerable interest to other persons besides geologists, and showing that he could extend his observations to the stratification of society around him as well as that of the earth beneath his feet. He paid a second visit to America in 1845, when he closely examined the geological formation of the Southern States and the coasts that border on the Atlantic and the Gulf of Mexico, and more especially the great sunken area of New Madrid, which had been devastated by an earthquake 30 or 40 years previously. Upon reaching England, he published his 'Second Visit to the United States,' a companion to his former work. For his other scientific papers we must refer our readers to the 'Proceedings' of the Geological Society, 1846–49, and its 'Transactions.'

"Late in life, about ten or twelve years ago, Sir Charles Lyell published another very important work, on 'The Antiquity of

Man,' summarizing and discussing all the important facts accumulated up to that time in favor of the high antiquity of the human race, viewed from the standpoints of the archæologist, the geologist, and the philologist.

"Numerous honors were conferred on Lyell in recognition of his services to science. As far back as 1836 he was elected to the Presidential Chair of the Geological Society, to which he was re-elected in 1850. He received from Her Majesty the honor of knighthood in 1848, and in 1855 the honorary degree of D.C.L. of the University of Oxford was conferred upon him. He had been for many years a Fellow of the Royal Society, and in 1838 received one of the Royal Society's Gold Medals for his 'Principles of Geology.' In 1858 the Royal Society conferred upon him the highest honor at their disposal—the Copley Medal; and in 1864–5 he filled the Presidential Chair of the British Association for the Advancement of Science. He received the Wollaston Gold Medal from the Geological Society of London in 1865 (his continued official connection with which had precluded his receiving it earlier). He was raised in 1864, on the recommendation of the then Prime Minister, Lord Palmerston, to a Baronetcy, which now becomes extinct by his decease. He was a Deputy-Lieutenant for his native county of Forfarshire.

"Sir Charles Lyell has been so long and so honorably known among the scientific teachers of the time, that though he had arrived at his seventy-eighth year, and the period of his chief intellectual and physical activity had long passed away, probably even the younger men of the present generation will feel that science is poorer by his loss.

"At the meeting of the Geological Society of London, held in the Society's room, Burlington House, Picadilly, on Wednesday last (February 24th), the President, John Evans, Esq., [redacted]

fellow-laborer in science, Sir John Herschel, in Westminster Abbey."

We add the following appreciative remarks from Nature of March 4th.

"Lyell's claim to fame lies in this, that he organized the whole method of inquiry into the history of the formation of the crust of the earth, and established on a sound footing the true principles of geological science; his theory being that, by the uniform action of forces such as are now in operation, the visible crust of the earth has been evolved from previous states.

"Lyell was not only a keen investigator of natural phenomena; he was also a shrewd observer of human nature, and his four interesting volumes of travel in America are full of clever criticism and sagacious forecasts. His mind, always fresh and open to new impressions, by sympathy drew towards it and quickened the enthusiasm of all who studied nature. Had he done nothing himself, he would have helped science on by the warmth with which he hailed each new discovery. How many a young geologist has been braced up for new efforts by the encouraging words he heard from Sir Charles, and how many a one has felt exaggeration checked and the faculty of seeing things as they are strengthened by a conversation with that keen sifter of the true from the false!

"Though by nature most sociable and genial, yet Sir Charles often withdrew from society where the object of his life, the pursuit of science, was not promoted; but when anything interesting turned up he always tried to share his pleasure with all around. Many of us will remember the cheerful and hearty 'Look here'—'Have you shown it to so and so?'—'Capital, capital'

"The little wayside flower, and, from early happy associations, still more, the passing butterfly, for the moment seemed to engross his every thought. But the grandeur of the sea impressed him most; he never tired of wandering along the shore, now speaking of the great problems of earth's history, now of the little weed the wave left at his feet. His mind was like the lens that gathers the great sun into a speck and also magnifies the little grain he could not see before. He loved all nature, great and small.

"Much we owe to Leonard Horner, himself a good geologist, for having inspired the young Charles Lyell. In after years, when already well known, Charles Lyell chose as his wife the eldest daughter of his teacher and friend. Many have felt the charm of her presence—many have felt the influence of the soul that shone out in her face; but few know how much science directly owes to her. As the companion of his life, sharing his

labor, thinking his success her own, Sir Charles had an accomplished linguist who braved with him the dangers and difficulties of travel, no matter how rough; the ever-ready prompter when memory failed, the constant adviser in a l cases of difficulty. Had she not been part of him she would herself have been better known to fame. The word of encouragement that he wished to give lost none of its warmth when conveyed by her; the welcome to fellow-workers of foreign lands had a grace added when offered through her. She was taken from him when the long shadows began to cross his path; but it was not then he needed her most. When in the vigor of unimpaired strength he struggled amongst the foremost in the fight for truth, then she stood by and handed him his spear or threw forward his shield. He had not her hand to smooth his pillow at the last, but the loving wife was spared the pain of seeing him die.

"It doubtless occurred to many a one among the crowd who saw him laid to rest among the great in thought and action, that he might have been eminent in many a line besides that he chose.

"His was a well-balanced judicial mind, which weighed carefully all brought before it. A large type of intellect—too rare not to be missed. But it was well that circumstances did not combine to keep the young laird on his paternal lands among the hills of Forfarshire: it was well for science that he was induced to prefer the quieter study of nature to the subtle bandying of words or the excitement of forensic strife. Failing health had for some time removed him from debates. Still to the last his interest in all that was going on in the scientific world never failed, and nothing pleased him more than an account of the last discussion at the Geological Society, or of any new work done. As a man of science his place cannot be easily filled; while many have lost a kind, good friend."

The number of *Nature* for August 26, contains an excellent portrait of Sir Charles Lyell, accompanying a biographical notice by Prof. Giekie.*

A list of Lyell's memoirs to the close of 1863 will be found in the Royal Society Catalogue, numbering, with his elaborate works, no less than seventy-one separate communications in his own name, and five more in connection with others.

* Artist's proofs of this portrait (engraved on steel by C H. Jeens) may be had at the office of *Nature*, 29 Bedford Street, Strand, London, W. C. Price 5s. each.

ART. XXXVI.—*On the Arithmetical Relations between the Atomic Weights*; by M. D. C. HODGES.

THE group of elements, fluorine, chlorine, bromine and iodine, have, as their atomic weights, 19, 35, 5, 80 and 127 respectively. These numbers form a series, in which the difference between the succeeding terms is at first 16·5, then 44·5, and finally 47. The following groups of elements give similar series.

			Li=7	
C=12	O=16	N=14	Na=23	Mg=24
Si=28	S=32	P=31	K=39	Ca=40
	Se=79·4	As=75	Ru=85·5	Sr=87·5
	Te=128	Sb=122	Cs=133	Ba=137

The grouping of some of the above elements may be objected to, but there is no great change from that generally accepted.

If a group of such elements as copper, silver, cadmium, mercury, lead and bismuth is taken, the series of atomic weights gives a similar, but somewhat different result; in this case each term of the series is composed of several members.

Cu=63·4	(Zn=65·2)	The new difference, 96+, for the higher terms occurs.
Ag=108	Cd=112	
Hg=200	Pb=207	Bi=210

Zinc may be added to the first term, and corresponds to the second member of the second term. The lower terms are here wanting. Similar to these are the following:

Ru=104·4	Rh=104·4	Pd=107	
Au=196·7	Pt=197·4	N=197·4	Os=199·4

Many of the remaining elements may be placed in the following series:

Be=9·4	Ti=50	In=75·8	Y=68	V=51·3
Al=27·4	Nb=94	U=120	E=112·6	Mo=96
Th=231	Ta=182	Tl=204		W=184

Sn(=118) may be placed as a second member of the fourth term of the series containing arsenic and antimony.

There remain chromium, manganese, iron, nickel, cobalt, zirconium, cerium, lanthanum, didymium, hydrogen and boron. The position of these may be better seen in the annexed table, in which all the elements, with the exception of hydrogen, are arranged on lines, the succeeding elements in the same line differing in their atomic weights by a few units or parts of units, and those in different lines from the corresponding elements in the preceding or following line by one of the differences mentioned.

		2·6				·00125	·00143		·979	1·743
(1.)	Br 9·4	Bo 11	C 12	----	----	N 14	O 16	F 19	Na 23	Mg 24
	2·56		2·49			1·826	2	·003	·865	1·577
(2.)	Al 27·4	----	Si 28	----	----	P 31	S 32	Cl 35·5	K 39	Ca 40
					7·43	5·63	4·24	3·1872	1·52	2·542
(3.)	----	----	----	----	In 75·8	As 75	Si 79·4	Br 80	Rb 85·5	Sr 87·5
				7·29	18·33	6·7	6·183	4·95		
(4.)	----	----	----	Sn 118	U 120	Sb 122	Te 128	I 127	Cs 133	Ba 137
(5.)										
(6.)	M 231	----	----	----	----	----	----	----	----	----
(1.)										
						5·5	6·8	7·2	7·8439	8·8
(2.)	----	----	----	----	Ti 50	V 51·3	Cr 52	Mn 55	Fe 56	Ni 58
						8·64				
(3.)	Zr 89	Ta 90	Ce 91·2	Di 94	Nb 94	Mo 96	----	----	----	----
(4.)										
						19·13				
(5.)					Ta 182	W 184	----	----	----	----
(6.)	----	----	----	----	----	----	----	----	----	----
(1.)										
	8·5					8·9		6·8		
(2.)	Co 59	----	----	----	----	Cu 63·4	----	Zn 65·2	----	Y 68
		11·2	12·1	11·4		10·67		8·7		
(3.)	----	Ru 104·4	Rh 104·4	Pd 107	----	Ag 108	----	Cd 112	----	E 112·6
(4.)										
		19·5	21·5	21 13	21·4	18·69	11·86	11·4	9·9	
(5.)	----	Cu 196·7	Pt 197·4	Ir 197·4	Os 198·4	Hg 200	Th 204	Pb 207	Bi 210	----
(6.)	----	----	----	----	----	----	----	----	----	----

The double line marks the positions possibly not occupied by any elements.

this table all of the above series are given, and the series, sting of several members for each term, also, find their . When we start from Be=9·4 and notice the following ents in the same line, we find that the atomic weights con- lly increase till Mg=24 is reached; there are no more ents in the same line, the next highest being Al(=27·4) e second line; the case is similar for this line, the atomic its increasing to Ca(=40), the next above being in the line. The difference between the first and second lines out sixteen units; it becomes forty-four plus for the second hird, and third and fourth; and is, finally, about ninety- for the last term of the series, from Ti, Nb, Ta to Be, Al, These three differences do not seem to be constant, but to ase with the values of the atomic weights; this is most ent for the largest; the smallest appears constant.

would seem probable that the lower terms of the series magnesium, and as far as aluminum, should be wanting; therwise, there would be two elements of equal atomic its and differing largely in their chemical natures; which would be shown by their having to be placed in different of the table, which does not occur. From Ba(=137) to ext highest, Ta(=182) is forty-five units, about the value e middle difference. If there were other elements be- n these, there would be a similar anomaly to that just ioned. The last terms of the series having the largest ence for their last terms, are Ta(=182) to Th(=231); the ase in these is forty-nine units. It may be that Th(=231) largest atomic weight.

e advantage of the table is its bringing elements of similar ical and physical characters together. The metals and lloids are separated almost completely.

ere are certain objections to the classification of some of lements in the series in which they have been placed. It rs that the chemical properties do not always exactly spond in the members of the same series; this is best n in the case of the soluble oxides and sulphides; others ose of thallium and lead, and perhaps silver. The boun- s in neither of these cases are to be considered sharp, and th are oblique.

ere is a singular fact in regard to the specific gravities of elements, when thus arranged. The specific gravities of elements in the same line vary regularly and have one mum and minimum; the maximum is in each case in the borhood of the members of the gold group, and the num among the metalloids; the positions of these two s are farther to the right, the lower the line; this is best for the minimum. The numbers above the symbols give pecific weights. Uranium is an exception.

From what precedes it appears: 1, that the atomic weights of elements of similar properties form series, the difference between the lower terms of which series being sixteen, for the middle terms forty-four to forty-seven, and for the largest eighty-eight to ninety-six; 2, that certain terms of some of these series may be wanting.

This law, together with the law in regard to the variation of the specific gravities in the different lines of the given scheme of the elements, could be used in fixing the value of a new atomic weight after its determination by analysis. The specific gravity being known, there could be two points equally distant from the maximum or minimum in each line, in which, in general, the element could be placed; the value as found by analysis, or one of its multiples, would satisfy one of these positions.

It is somewhat strange that there is no position for hydrogen in the table.

Art. XXXVII.—*On Southern New England during the melting of the great Glacier*; by James D. Dana. No. II.*

II. Absence of marine life from Long Island Sound through the Glacial and part of the Champlain periods.

The fact that the stratified estuary and seashore deposits of the New Haven region, and of other parts of the Connecticut coast bordering on the Sound, afforded me no trace of marine life was a puzzle so long as I looked upon them as true beach made accumulations. I have continued my search at various localities, up to the present time, and in no case have I met with shells or other sea-relics. The evidence proves that the deposits are not of beach origin, but drift deposits made by the waters and gravel or sand of the melting glacier as they together hurried onward in floods to the sea, conjoined there with the action of the tidal currents and waves, and it establishes also, as I believe, that true shell-bearing sea-beaches do not here exist.

The same absence of marine productions appears to characterize the drift along the northern shore of Long Island, or southern side of the Sound. The extended investigations of Professor Wm. W. Mather while geologist of the State of New York brought nothing of the kind to light; and my own recent examinations of the drift on the Island have been as barren of discovery. Moreover, I could [illegible] no evidence from persons living in

* For No. I of this Memoir, see page 168.

the sea-border towns that any shells had been found in the drift deposits *

Long Island Sound—the strip of water, 100 miles long and 5 to 20 miles wide, separating Long Island from Connecticut—is a very shallow trough. Its depth from its western limit to the mouth of the Connecticut river nowhere exceeds (as the Coast Survey charts show) 170 feet, and in general is between 75 and 100 feet; and through the small eastern portion, east of the Connecticut, it is for the most part under 200 feet. The depth was probably less than this in the Glacial era, since there is strong evidence that the water line was then at least 100 feet below its present level. However this be, so shallow a trough should have been occupied throughout with ice, if the glacier over Southern Connecticut were 1 500 feet in thickness, or even 1,000 feet; moreover the trough would have been the course at bottom of one of the largest of New England subglacial streams, since all the subglacial rivers passing through the State of Connecticut, including the chief river of New England, the Connecticut, would have been its tributaries. As the Champlain period opened the land subsided, giving greater depth of water to the Sound than now exists. But, with the melting going forward, the great stream of the Sound would have been swollen immensely in volume, and finally have borne icebergs seaward.

Such being the glacial conditions, the continuance of molluscan, articulate and verbetrate marine life in the Sound, like that now existing there, would have been impossible, and an extermination nearly or quite complete of the old fauna must hence have taken place.

After the melting of the glacier had ended. the return of the old species to the Sound sooner or later began; and it was probably accomplished before the Champlain period—the era of low level and great rivers—ended; but, with no elevated beaches to refer to as proof, the evidence of this fails us. The glacier had probably exterminated the temperate-climate life also of the seas just south of Long Island; for numerous bowlders, from one ton to two thousand tons in weight, of New England origin, show that the ice stretched on from the Sound in full force over Long Island, and must have had its terminal ice-cliffs somewhere to the south in the shallow water of the

* Prof. Mather in his New York Geological Report (p. 262) gives, from the verbal reports of others, statements respecting the discovery of shells on Long Island, which are, in part at least, of uncertain credibility, and are supposed by him to indicate, where of value, the presence of Tertiary deposits or of Tertiary and upper Cretaceous, beneath the Drift. Besides the localities on Long Island, at depths varying form thirty to more than a hundred feet, shells are stated to have been obtained on Governor's Island, in New York Harbor, at a depth of about 100 feet. None of the shells or localities have ever been seen by a geologist, so that the precise value of the evidence is still in doubt.

Atlantic border, if not along the southern shores of this island. Under these circumstances the old life, which might early have repeopled the southern shores of Long Island and the seas on the east, would have been slow in repossessing itself of Long Island Sound.

Although the Sound has yet afforded no evidence of molluscan life in the Champlain period, there is a deposit full of shells, according to Mr. Sanderson Smith,* on Gardiner's Island, off the east end of Long Island at the entrance to Peconic Bay. The bed has a height of fifteen or twenty feet above the sea level. The species mentioned in the article are: *Nassa trivittata*, *N. vibex* Say, *Fusus decemcostatus?* Say, *Purpura lapillus* Lam., *Columbella lunata* Say, *Natica duplicata* Say, *Chemnitzia interrupta* Stimp., *Crepidula unguiformis* Lam., *C. fornicata* Lam., *Bulla canaliculata* Gould, *Ostrea borealis* Lam., *Pecten Islandicus* Chemn., *P. Magellanicus* Lam., *Arca transversa* Say, *Cardita borealis* Conrad, *Astarte sulcata* Fleming, *Venus mercenaria* (very thick and heavy shells, broken but not rolled and making the bulk of the deposit), *Mactra lateralis* Say, *Mya arenaria* Linn., besides three other doubtful species.

In the above remarks I have assumed that the ice which carried the bowlders to Long Island was that of the glacier and not of detached icebergs; in other words, that the glacier did not terminate along the Connecticut shores in the early part of the Champlain era during the melting, and give off icebergs for farther southward transportation. This point, which has some arguments in its favor, I propose to consider in a future paper on the geology of Long Island. Even if the glacier had its southern limit along Southern New England, the Sound would have been filled with the floating masses, and its waters, greatly freshened by the under-glacier streams, poured in along the whole coast and by the melting of icebergs; the exclusion, therefore, of the molluscan, articulate and vertebrate life of existing species from the Connecticut coast would have been nearly or quite complete.

ART. XXXVIII.—*Corals at the Galapagos Islands*, by L. F. POURTALÈS.

THE Galapagos Islands are, as is well known, an important point in the geographical distribution of corals, being almost exactly on the boundary of the coral-producing part of the Pacific Ocean, and that portion which is destitute of them on account of the low temperature of the water. All the writers

* Ann. Lyc. Nat. Hist. of New York, viii, 149, May, 1865.

n the subject have placed this group of islands in this latter ortion. During the visit of the United States Coast Survey eamer Hassler, a number of specimens of corals, of which ie following is the list, were picked up on the beaches of several of the islands:

Ulangia Bradleyi Verrill, Indefatigable Island.
Pavonia gigantea Verrill, James Island.
Pavonia clivosa Verrill, Indefatigable Island.
Pavonia, sp., James Island.
Astropsammia Pedersenii Verrill.
Pocillipora capitata Verrill, Jervis and Charles Islands.
Porites, sp.

The undetermined *Pavonia* is a massive species with larger alicles than those of the two other ones, and more porous and ghter. The specimen is too much rolled for nearer determination. The *Porites* is massive. also, and in the same condition.

The species are all, or nearly all, identical with those found t Panama. They are mostly reef-builders, but here live probbly isolated and at a certain depth, having never been oberved *in situ*. In individual growth they are fully equal to iose from more favored localities, the rolled pieces of *Pavonia* ieasuring six or seven inches in diameter, thus indicating iasses of considerable size originally. They are not confined the northernmost islands of the group, where we should iore naturally look for them, from the greater proximity to ie warm current, but as the list shows, a *Pocillipora* was found Charles Island, one of the southernmost. The probability fragments drifting from one island to the other is very small, wing to the considerable depth of water between them.

RT. XXXIX.—*A Comparison between the Ohio and West Virginia sides of the Alleghany Coal-field*; by E. B. ANDREWS.

[Read before the American Association, at the meeting at Detroit.]

IN the study of the Alleghany coal-field it is necessary to ive some well defined geological horizon to serve as a datum ie with which to collate the various strata. Sometimes the iderlying formation—conglomerate in western Pennsylvania id Waverly in Ohio—is taken for such base line and measureents are made to the strata above and the coal-seams are ttered or numbered accordingly. But the conglomerate is an icertain formation and the Waverly presents a very undulatg and uneven surface, as shown by Mr. M. C. Read and yself in the Ohio Geological Reports. In this discussion, I

prefer to take the horizon of the Pittsburgh seam of coal as the base of measurement.

This seam is of wide extent, being 225 miles long and about 100 miles wide, and is easily recognized by geologists. It has been asserted that this seam was formed in a trough with the Allegheny mountains forming a sloping side on the one hand and the Cincinnati uplift on the other, and as the subsidence—which is conceded to have been regular and uniform—continued, the marsh, with its accumulated vegetable matter, crept up either slope. In time the center or lowest part was buried by sediments and new land surfaces were formed on which vegetation grew and other resulting seams of coal stretched across the trough from side to side like the chords of an arc, but all coalescing with the great seam ever rising along the margins to meet them. I know of no proof whatever that the Alleghany mountains were uplifted just before the era of the upper coal-measures, nor is there any that the slope on the side of the Cincinnati uplift differed at the time the Pittsburgh seam was formed from what it had been during the era of the lower coal-measures. There is, furthermore, no proof that the upper and lower coal-measures are unconformable, as they must necessarily be if the theory controverted be true. Moreover, as a matter of fact, in Ohio, in locations which I have carefully examined, where the seams above the Pittsburgh seam are said to coalesce with the latter, there is no such coalescing, but the seams continue westward long distances beyond the points where the union is supposed to have taken place.

Disregarding, therefore, the discredit attempted to be thrown upon the great Pittsburgh seam as exceptional in its mode of formation, I shall confidently assume it as a trustworthy datum line to guide us in our investigations.

This seam occupies nearly the center of the northern and wider part of the Alleghany coal-field and extends through portions of Pennsylvania, Ohio, and West Virginia. It does not reach Kentucky, its limit of extension to the southwest being not far from the mouth of the Guyandotte river in West Virginia.

Now, if we take this seam of coal and follow around its line of outcrop and measure from it down to the base of the productive coal-measures, we find the intervals quite uniform through the larger part of the circuit. In Ohio, according to Dr. Newberry's measurements and my own, it is from 700 to 800 feet. In Pennsylvania on the Alleghany river north of Pittsburgh it is reported by Prof. H. D. Rogers to be from 600 to 700 feet; or 800 feet including the conglomerate underneath. In the northern part of West Virginia, a little south of the Pennsylvania line, it is reported to be 500 feet. But in West

Virginia farther south, the interval is far greater, as will be shown. If we make a section across the whole coal-field, including the Ohio side of the synclinal axis, taking the general line of the Kanawha river, we find the southeastern side of that axis not only very much wider territorially, but also containing a much greater thickness or depth of productive coal-measures. The Pomeroy seam of coal, which I have shown in the Ohio Geological Reports to be identical with the Pittsburgh seam, dips to the southeast under the Kanawha river a little above its mouth. A few miles higher up the river, it reappears on the other side of the synclinal axis and has been identified by Prof. W. B. Rogers and others. From this point we descend the geological series in going to Charleston, or perhaps to a point a little above Charleston, through an interval estimated to be 700 feet. Professor Fontaine, who has contributed some valuable articles to the American Journal of Science on the Geology of West Virginia, writes me that he thinks it may be greater than this. From Charleston to the Kanawha falls we descend in the series from 1,100 to 1,200 feet. I measured the interval between the coarse conglomeratic sandrock of the falls and one of the upper coal-seams on Cotton mountain, a seam which is believed to dip below the river a little above Charleston, and found it nearly 1,200 feet. Prof. Fontaine estimates 1,200 feet as the thickness of the coal-measures between the top of the conglomeratic sandrock of the falls and the southeastern outcrop of the measures up New river. A thousand feet have been measured and he estimates 200 feet for a space not measured. This makes a total of 3,100 feet from the horizon of the Pittsburgh seam to the base of the Productive measures. This is exclusive of 2,132 feet of lower shales and limestones; the Lewisburg limestone, according to Prof. Rogers, being 822 feet thick. This limestone is perhaps local, as Prof. J. P. Lesley makes no mention of finding it in his investigations in Tazewell, Russell and Wise Counties, to the southwest, where he found the lower coals and underlying Devonian rocks caught in curious lines of faults and upthrows which have brought to the surface lower Silurian limestones. But the Lower Carboniferous limestones appear in full force farther southwest in Tennessee. We have, therefore, about 2,400 feet more depth of Productive coal-measures below the Pittsburgh seam in West Virginia than in Ohio and Western Pennsylvania. My own personal explorations on the tributaries of the Kanawha, and on the upper waters of the Guyandotte and of the Tug fork of Big Sandy lead me to the belief in a corresponding thickness of coal-measures in all that portion of the State extending southwestward into Kentucky.

Perhaps the most valuable range of bituminous coals in the United States is that belt, which, beginning upon Elk river,

passes the Kanawha between Charleston and Kanawha falls, includes the Coal river field, and crosses the Guyandotte, the upper Twelve Pole, and Tug and Louisa forks of Big Sandy. This belt belongs geologically to a space in the vertical series, which is below the horizon of the base of the coal-measures in Ohio and Western Pennsylvania. Yet below this group comes in another, which Prof. Fontaine designates as the Conglomerate series. If we replace the strata, now inclined on either side of the synclinal axis, in their original horizontal position, we find the proof of a vast depression of the surface in this portion of West Virginia at the beginning of the series of Productive coal measures. It was doubtless a trough, a geosynclinal, according to Prof. Dana's nomenclature, and a part of the great Appalachian system of the wrinkling and folding of the continent. To the southeast there were at the time elevated lands of older formations, stretching along the same Appalachian line of disturbance and upheaval.

On the northern and western side of this vast basin lay the marginal plateau of the Waverly more than 2,000 feet high, with the yet higher lands of the Cincinnati uplift in the distant western background. This trough had somewhere a connection with the ocean and gradually sank below the water, while at the same time the rivers from the highlands, more or less remote, brought in sediments of various kinds. The muds and sands sometimes accumulated so as to be above the water and, during intervals of repose in the subsidence, vegetation crept out over the newly formed surfaces and formed great marshes, which, when subsequently buried, gave to mankind seams of coal. The spaces between the seams of coal were at first chiefly filled with sand which now constitutes the massive sandrocks which characterize the whole region of the lower coals of West Virginia. Sometimes the sands were coarse and gravelly and formed true conglomerates. The conditions favorable to the formation of limestone did not exist, and in the lower 2,000 feet of accumulations, I have seen, in all my extended explorations of the region, only a single limestone layer, and that in Webster County, on the head of Elk river. I had no opportunity to examine it for fossils.

When at last, in the subsidence, this basin was filled, the waters came over the marginal plateau to the north and west, a region remarkable for its stability and for the uniformity and evenness of its subsidence. At first, over the newly submerged space was spread a more or less continuous sheet of coarse sand and gravel which now constitutes the coal-measure conglomerate of Ohio and Western Pennsylvania. The continuity of the sheet is often broken and large areas around the margin of our Ohio coal-field show no conglomerate whatever. The first

coal marshes grew in the hollows and depressions of the Waverly, depressions formed, it may be, wholly or in part, by erosions from surface drainage during the long period in which the formation had remained high and dry land. After the whole plateau had been submerged the same process of filling up, and marsh-forming and coal-making, went on, as has already been described, with the exception that the waters were more habitable and the layers of fossiliferous limestone show the remains of crinoid, mullusk and fish.

Less sand and more mud was brought in and shales abound, although sandstones are not uncommon, even those that are conglomeratic in character. The Pittsburgh seam of coal, which I have used as my basis of measurement, was by no means the last in the upward series. There are above it in West Virginia, probably 1,200 to 1,500 feet of coal-measure rocks, with several seams of coal. This would give from 4,300 to 4,500 feet of productive coal-measures in that favored State. No other State in the Union contains so great a vertical range.

This great Kanawha basin or trough originally extended to the south or southwest so as to include the area in which the coals of Montgomery county, Va., were formed, for these coals are doubtless the equivalents of the lowest on New river, as are also the remnants and outliers of coal in Tazewell, Russell, and Scott counties.

The subsequent upheavals and erosions have thrown great difficulties in the way of determining the course and extent of this ancient trough. I have no sections along the southeastern side of the coal-field in Kentucky—for these we must look to Prof. Shaler, now engaged in the prosecution of the Kentucky Survey; but in northern Tennessee, on the same side of the field, Prof. Safford reports about 2,500 feet of coal-measures above the horizon of the Mountain limestone. It is impossible, in the absence of sections through Kentucky, to determine whether these 2,500 feet in Tennessee were formed in a trough of equal depth with that on the Kanawha. It was doubtless approximately so, and we have here a clue to the direction of the trough to the southwest. If the Lewisburg, West Virginia, limestone is the equivalent of the Mountain limestone of Tennessee, we may infer that this formation, wherever it existed along the line of the geosynclinal depression, was carried down, while the lower Carboniferous limestone of Ohio and Northeastern Kentucky, on the northwestern side of the synclinal axis, were not involved in the movement. In southern Tennessee, Prof. Safford reports in one of his sections only about 800 feet of coal-measures above the Mountain limestone, the upper 1,700 feet having doubtless been removed by denudation. If not thus removed, the limestone was not carried

down in the geosynclinal, but remained on the higher margin as in Ohio, and the original trough by which connection was had with the sea lay probably to the east.

Did the same geosynclinal trough extend in the opposite direction from the Kanawha valley, i. e., to the northeast through Pennsylvania? If the equivalency of the Pittsburgh seam has been rightly determined in the Cumberland and Broad Top coal-fields, we have in the former, according to Mr. Tyson, 1,100 feet of productive measures below that seam, and in the latter about 700, according to Prof. Lesley. Prof. Lesley has recently reported finding in the Broad Top field thin coals in the lower Carboniferous, in strata which he regards as equivalents of the Waverly Berea grit of Ohio. This is a discovery of the highest interest, but it will not effect this discussion, since I confine myself to what we term the Productive coal-measures. The geological interval between the middle of the Waverly, with the Chester limestone above, and these measures is a very great one. It may be remarked in this connection that there are doubtless areas where the lowest portions of these measures contain no register of themselves in seams of coal, the conditions of coal-making not existing, but we have so little definite information on this point that it appears to be necessary to make our limit of depth the lowest known coals of the proper coal-measures. It is quite possible, for example, that the shales, &c., between the lowest coal-seam on New River, West Virginia, and the Lewisburg limestone may somewhere contain seams of coal, but it is not best in this paper to assume the existence of such facts.

In the anthracite coal fields of Pennsylvania there is so much uncertainty as to an equivalent of the Pittsburgh seam that I fear we shall gain little or nothing from them to bear upon the question of the original depth of the basin in which they were formed. Prof. Lesquereux, in his chart of grouped sections in the fourth volume of the Kentucky Survey, places all the coal-seams of Wilkesbarre, Pittston, Scranton and Carbondale below the horizon of the Pittsburgh seam. In the Pottsville region Mr. Daddow claims that seam G. of his series, is the equivalent of the Pittsburgh seam. The seam G. is 650 feet above the lowest seam in the series, one imbedded in conglomerate. If we accept this equivalency we find no proof of the existence of the deep geosynclinal trough in that direction. If, again, the conglomerate under the anthracite basins is the equivalent of the conglomerate of Western Pennsylvania and Ohio, and they were once one and continuous as the Pennsylvania geologists affirm, then, since to the west, the conglomerate was not deposited until after the great West Virginia trough was filled and the waters in the general subsidence

over the great marginal plateau already described, we
well infer that there could not have been an extension
gh the anthracite region of the geosynclinal valley.
; was only enough of greater depth to include the in-
:d thickness of the conglomerate.
ɜ comparison of the two sides of the Alleghany coal-
suggests a very great difficulty in regard to the determina-
of the place of what is termed the coal-measure Conglom-
Is there an established horizon for such Conglomerate
merican geology? In Ohio we now are in the habit of
g that rock the Conglomerate which, when found at all,
ipon the Waverly (although formerly the Waverly con-
:rate was also thus designated) and is approximately from
.o 800 feet below the horizon of the Pittsburgh seam of
The same Conglomerate extends under the bituminous
ield of Western Pennsylvania and holds the same rela-
o the Pittsburgh coal. This conglomerate horizon should
the same relative distance below the Pittsburgh seam in
Virginia, and I think I have probably found lithological
of it in a very coarse conglomerate on Elk River—a
h of the Kanawha which enters the latter at Charleston.
ıe Kanawha Falls is a conglomerate more than 1000 feet
in the series. This rock has been honored with a capital
d the coals in the 1200 feet below it are spoken of as the
lomerate series. Still below this series and below all the
Prof. W. B. Rogers finds another conglomerate in the
River valley as does Prof. Lesley under the lowest coals
; faults and upthrows to the southwest. Now if the coal-
ıre Conglomerate is a geological horizon and not merely
k, these various strata cannot all be the true Conglom-
We find conglomerates everywhere in the vertical range
e coal-measures. They are found even above the horizon
e Pittsburgh seam. Heavy conglomerates abound along
estern side of the eastern Kentucky coal-field, at various
tions above the lower Carboniferous limestone, and the
is true in Tennessee.
the Indiana and Illinois coal-field, the coal seams of which
never been synchronized with those of the Alleghany
ield, we have reported a conglomerate or millstone grit,
ıo one knows its exact place in the great time scale, or
ıer it is the equivalent of any of the half dozen well-
ed conglomerates of the Alleghany field. So far as we
know it may have no equivalency any where.
Arkansas there is a conglomerate called in the Geological
rts the Millstone grit. The available coals of the State
ıid to lie below it, and are therefore called the Sub-Con-
erate coals, although Prof. Lesquereux asserts that they

belong to the true coal-formation and cannot be separated from it. The conglomerate in this case can have nothing more than a lithological significance.

In the South Joggins coal-field at the head of the Bay of Fundy, Sir Wm. Logan reports 14,570 feet of coal-measures. In this vast series of strata, and not very far from the middle of it, Dr. Dawson, in his admirable work on Acadian Geology, finds a group of coarse sandrocks which he denominates the Millstone Grit series. Here the millstone grit is not known to be the equivalent of the millstone grit of Great Britain, nor of any of our conglomerates of the United States.

In view of this confusion, I think all will agree with me that the terms *millstone grit* and *coal-measure conglomerate* should either be used to designate a uniform horizon in the Carboniferous system or be abandoned as geological terms and retained only for their lithological meaning.

I close this paper with another remark by way of inference, viz: that there is need of an entire revision of the classification of the coal-seams of the great Alleghany coal-field. It seems strange to begin in the middle of the vertical series and call a seam of coal No. 1, or letter A, and enumerate upward, while all the seams below are left without enumeration. But the data for such revision are not yet sufficient.

ART. XL.—*Instinct? in Hermit Crabs*; by ALEXANDER AGASSIZ.

WHILE tracing the development of one of our species of Hermit Crabs I raised from very young stages a number of specimens till they reached the size when they need the protection of a shell for their further development. I was of course curious to see how they would act the first time when supplied with the necessary shells. For this purpose, a number of shells, some of them empty, others with the animal living, were placed in the glass dish with the young crabs. Scarcely had the shells reached the bottom before the crabs made a rush for the shells, turned them round and round, carefully examining them, invariably at the mouth, and soon a couple of the crabs decided to venture in, which they did with remarkable alacrity; and after stretching backward and forward, they settled down into their shell with immense satisfaction. The crabs who were so unfortunate as to obtain for their share living shells, remained riding round upon the mouth of their future dwelling and on the death of the mollusk, which generally occurred soon after in captivity, commenced at once to tear out the animal, and having eaten him, proceeded to take its place within the shell.

It is of course very difficult to apply to Invertebrates many of the laws of natural selection, and thus far we know so little of the habits of most of our marine animals that it is idle to speculate upon the effect of causes which may effectually modify the life of higher animals. In the case above mentioned there is no possible connection between the embryo and the parent to account for the young having learned from the former the use of the shell and its value for his existence. We can, therefore, only explain the faculty of performing this act as inherited, or else as a simple mechanical act rendered necessary by the conditions of the young hermit crab. The latter seems the more probable case from the nature of the test of the hermit crab in its younger stages. While the young hermit crab soon after leaving the egg is still provided with its powerful temporary swimming feet, and while the feet of the adult can only be traced as mere rudiments behind them, the whole test of the cephalothorax and abdomen (which are symmetrical) is of considerable consistency up to the last moults preceding the stage when it seeks a shell. At that time the young are no longer symmetrical, the feet, which are now fully developed being largest on the right side and the abdomen, beginning to curve in the same direction away from the longitudinal axis. When the moult has taken place which brings them to the stage at which they need a shell, we find important changes in the two hind .pairs of feet, now changed to shorter feet capable of propelling the crab in and out of the shell; we find also that all the abdominal appendages except those of the last joint are lost, but the great distinction between this stage and the one preceding it is the curling of the abdomen; its rings, so distinctly marked in the previous stages are quite indistinct and the test covering it is reduced to a mere film, so that the whole abdomen becomes of course very sensitive. It is therefore natural that the young crab should seek some shelter for this exposed portion of his body, and from what I have observed, any cavity will answer the purpose; one of the young crabs having established himself most comfortably in the anterior part of the cast skin of a small isopod, which seemed to satisfy him as well as a shell, there being several empty shells at his disposal. This mechanical explanation still leaves unanswered the eagerness with which the crabs rushed for the shells, their careful examination of its openings, their taking the animal out and occupying his place; all acts which seem to require considerable intelligence?, and to show remarkable forethought?.

Newport, Aug. 23, 1875.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On the Constitution of Ammonium Compounds.*—In their previous paper,* Meyer and Lecco established the identity of the two di-methyl di-ethyl derivatives of ammonium, whether obtained from di-methylamine and ethyl iodide on the one hand, or from di-ethylamine and methyl iodide on the other, by the complete equality of their physical properties, and of their chemical reactions in solution, by the identity of their decomposition-products at high temperatures, the equal solubility of their platinum salts, which were identical in crystalline form, and by the exact similarity of fusing point of their picrates. To these particulars, they now add the crystallographic identity of their picrates as determined by Groth and Arzruni. Lossen having objected that the conclusion drawn from the above facts—i. e., that nitrogen was a pentad in these compounds—was not warranted unless it could be shown that no exchange of radicals took place within the molecule, the authors have made a series of experiments to test this question. By acting on tetra-methylammonium iodide with ethyl iodide, there would result, if an exchange did actually take place, the following reaction:

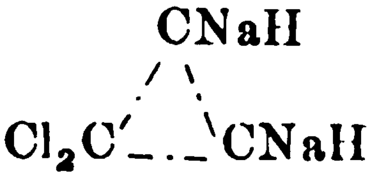
$$N(CH_3)_4I+C_2H_5I=N(CH_3)_3C_2H_5I+CH_3I.$$

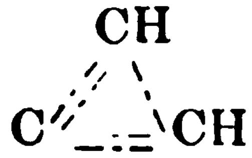
The two substances were heated together in a sealed tube, first to 100° and then to 150° (the original reaction having been completed at 80°); but no trace of any reaction could be detected. The same result was obtained when methyl iodide was heated with tetrethylammonium iodide to 70°, to 150, and even to 180° (the previous experiments having been conducted at ordinary temperatures). The authors hence reiterate their conclusion that the ammonium derivatives are not molecular but atomic compounds and that in them, the nitrogen is quinquivalent.—*Ber. Berl Chem. Ges*, viii, 936, July, 1875. G. F. B.

2. *On Retene.*—Among the products obtained in the destructive distillation of wood, is a heavy oil often employed in lubrication This oil is very rich in the hydrocarbon retene, and Ekstrand has extracted this substance from it and submitted it to an investigation. On pressing the cooled oil, a grayish soapy mass is obtained having the odor of creosote and melting at 84°-85°. After washing with ether, solution in boiling alcohol, decolorization with animal charcoal and crystallization, pure retene is obtained in white micaceous scales, fusing at 98°·5 and having the composition $C_{18}H_{18}$. Crystallized retene has a density of 1·13, and fused of 1·08. It is readily soluble in boiling alcohol and glacial acetic acid, and in carbon disulphide, benzene, and ether. It unites directly with chlorine and bromine at ordinary temperatures and is readily oxidized by nitric acid. The picrate crystallizes

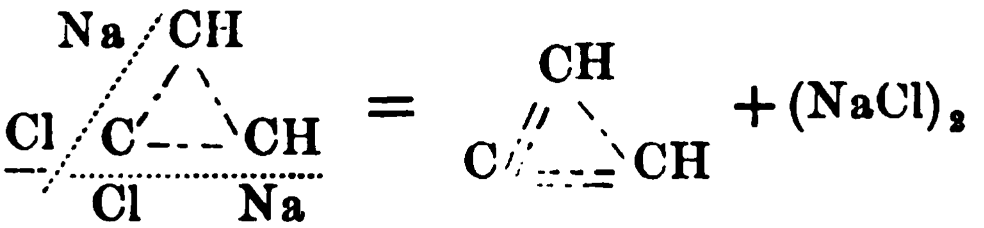
* This Journal for June, 1875, p. 462.

in orange needles. Di- and tetra-bromo-retene, and a sulpho-conjugated acid and its salts, are described. In acetic acid solution, chromic acid oxidizes it to dioxyretistene $C_{16}H_{14}O_2$ and to two other bodies, $C_{16}H_{16}O_3$ and $C_{18}H_{17}O_2$, both monobasic acids, forming well defined salts. Dioxyretistene reduced by zinc powder, yields dibenzyl. Hence he regards the retistene of Wahlforss as probably only a mixture of retene and dibenzyl.—*Bull. Soc. Ch.*, II, xxiv, 55, July, 1875. G. F. B.

3. *On Propargylene, a new hydrocarbon,* C_3H_2.—By the action of strong bases on croton-chloral, dichlorallylene, $C_3H_2Cl_2$ is obtained. PINNER has now observed that sodium is capable of uniting directly with this body, and that the product when decomposed by water, yields a gas having the composition C_3H_2, which he calls propargylene. If fragments of sodium be placed in dichlorallylene at ordinary temperatures, a slight almost imperceptible evolution of gas takes place, but in the course of half an hour, the sodium sinks to the bottom, having been converted into a brown dull mass, with a notable increase of volume. Finally, when somewhat less than a molecule of sodium has been added to one of dichlorallylene, the latter has entirely disappeared, the dry mass being the sole product. Water, alcohol, and ether decompose it, evolving torrents of gas and forming sodium chloride. It has not been obtained pure and its analyses are discordant; but its mode of formation gives it the probable formula $C_3H_2Cl_2Na_2$. If it be treated with water and the evolved gas be passed through bromine, this is absorbed, and a heavy oil is obtained, having the formula $C_3H_2Br_4$. By the action of potassium hydrate upon this, tribromallylene C_3HBr_3 is obtained and this unites directly with Br_2 to give C_3HBr_5 in white crystals. Propargylene gas passed through ammoniacal silver solution, gives a precipitate of fine white needles, which rapidly blacken even in the dark, and have the probable composition $(C_3H_2)_2Ag_2O$. Pinner regards the sodium compound as composed thus: 

, and propargylene thus: 

; and the decomposition of the former by water is represented as follows:



Hence this dichlorallylene is not a derivative of allylene proper, but is propargylene dichloride.—*Ber. Berl. Chem. Ges.*, viii, 898, July, 1875. G. F. B.

4. *Synthesis of a dextro-rotatory Malic acid.*—BREMER has published a preliminary note on a new malic acid which rotates the polarized ray to the right, produced from dextro-rotatory tar-

taric acid. Ordinary tartaric acid, iodine, phosphorus and a little water, were enclosed in sealed tubes and heated in a water-bath for several days. The mass was treated with water, the succinic acid crystallized out, the mother liquor diluted and the phosphoric and unattacked tartaric acid separated by milk of lime. Ammonium nitrate was added and the solution evaporated. On the addition of alcohol, calcium malate and succinate were deposited. They were converted into lead salts, the lead separated by H_2S, and the acids obtained by evaporation, were separated by the deliquescence of the former. Recrystallization of the acid ammonium salt afforded a pure malate, having the same form as the natural salt and fusing at 170° C. Examined with the Polaristrobometer of Wild, the salt was found to rotate to the right. The author is now engaged in the attempt to produce a left-handed malic acid from lævotartaric acid, in the hope that from the two an inactive malic acid may result, as racemic comes from the two tartaric acids.—*Ber. Berl. Chem. Ges.*, viii, 861, July, 1875. G. F. B.

5. *On Ethyl and Amyl-sulphocarbonates as remedies for the Phylloxera.*—Dumas, having shown that potassium sulphocarbonate, when mixed with the soil, evolves hydrogen sulphide and carbon disulphide, recommended this substance for destroying that pest of the grape culture, the phylloxera, since it was well known that carbon disulphide was rapidly fatal to them. Moreover, he showed that the hydrogen sulphide evolved simultaneously, did not, under these circumstances, seriously injure the grape plants, being rapidly oxidized in the soil. Experiments made by Zöller and Grete at the Agricultural High School of Vienna, have confirmed the excellence of potassium sulphocarbonate for this purpose; but they have also shown the equal usefulness of another compound, which, while at the same time evolving in the soil the noxious carbon disulphide, does not set free the injurious hydrogen sulphide. Moreover, while the former substance recommended by Dumas is difficult to prepare and is consequently high in price, the new compound can be made with facility and at a moderate price. This new body is potassium ethylsulphocarbonate or xanthate. A solution of this salt mixed with the soil, evolves CS_2 copiously. It is however better to mix the dry salt with a small quantity of earth and of superphosphate, and to scatter the dry powder about (or better directly upon) the roots. In this way, both the potash and the phosphoric acid become useful finally to the plant.

In a subsequent paper, the same authors give the results of some experiments on the action of the xanthate on plants. They found that even tender succulent plants growing in only half a liter of earth, could be treated with a gram of the above salt, with no injurious effect other than the loss of a few leaves. Shrubs were entirely unaffected when treated with from 3 to 5 grams. They also reply to Dumas's statement that the xanthate is too costly in France to be used practically, owing to the high price of alcohol, supposing the fused potassium hydrate out of the question. They

would replace the ethyl by amyl, forming thus the amylsulphocarbonate. This they find by experiment is equally efficacious with the other, has even less injurious action on plants and is far cheaper. Moreover, it may be made easier. If concentrated potassium hydrate solution be agitated with crude amyl alcohol, and carbon disulphide be added, the whole mass becomes warm and deposits potassium amylsulphocarbonate, in a form best suited for use. It may be employed either in solution or better mixed with superphosphate. As to cost, the authors estimate that at the present cost of amyl alcohol (fusel oil) in Vienna, it can be made for $15 a hundred weight. It is not only useful to exterminate the phylloxera, but also many other root parasites of plants.—*Ber. Berl. Chem. Ges.*, viii, 802, 955, June, July, 1875.

G. F. B.

6. *On the occurrence of Ethyl Alcohol in Plants.*—The occurrence of ethyl alcohol in the unfermented juices of plants is rendered probable by the fact that these juices contain not only acetic acid, its oxidation product, but also its homologues, methyl, hexyl, and octyl alcohols. GUTZEIT has made, in Geuther's laboratory, a somewhat extended investigation of this subject, using for the purpose *Heracleum giganteum*, *Pastinaca sativa*, and *Anthriscus cerefolium*. Six and a quarter kilograms of the fruit of the first plant being distilled with 18 kilograms of water, gave 12 kilos. of a distillate, from which the oil on the surface was separated by means of a syphon. The residue on distillation gave 12 to 15 grams of volatile liquids, which after rectification boiled between 72° and 77°, and consisted of methyl and ethyl alcohols, the latter consituting two thirds. By examining the fruit at various stages of growth, the author infers that as ripening approaches, the ethyl compounds gradually diminish, being converted into more condensed bodies; while the methyl compounds remain constant. The other plants mentioned gave a similar result.—*Liebig's Annalen*, clxxvii, 344, June, 1875.

G. F. B.

7. *On Arbutin.*—HLASIWETZ and HABERMANN have made a research upon arbutin, a glucoside extracted by Kawalier from the *Arctostaphylos uva-ursi* or bearberry. Its discoverer observed that it was easily split into glucose and a body which he called arctuvin, but which Strecker asserted to be hydroquinone. The authors find, however, that the body thus obtained is not pure hydroquinone, but is a mixture of this and its methyl derivative, methyl-hydroquinone $C_6H_4\left\{\begin{matrix}OCH_3\\OH\end{matrix}\right.$ isomeric with saligenin $C_6H_4\left\{\begin{matrix}CH_2OH\\OH\end{matrix}\right.$. Hence they assign to arbutin the formula $C_{25}H_{34}O_{14}$ and express its splitting by ferments, as follows:

$$\underset{\text{Arbutin.}}{C_{25}H_{34}O_{14}} + \underset{\text{Water.}}{(H_2O)_2} = \underset{\text{Hydroquinone.}}{C_6H_6O_2} + \underset{\text{Methyl-hydroquinone.}}{C_7H_8O_2} + \underset{\text{Glucose.}}{(C_6H_{12}O_6)_2}$$

One hundred parts of arbutin yield 19·7 hydroquinone, 22·5 methyl-hydroquinone and 64·7 sugar.—*Liebig's Annalen*, clxxvii, 334, June, 1875. G. F. B.

8. *A new Base obtained in the Aniline manufacture.*—JACKSON has examined in Hofmann's laboratory a new base obtained from the last run of the still in the manufacture of aniline. This product—a black tarry liquid with a disagreeable odor—was dissolved in hydrochloric acid, diluted and filtered. Upon addition of sodium hydrate, the bases were set free as a light oil swimming on the surface. This was fractionated, and the portion boiling between 280° and 320°, separated from naphtylamine by sulphuric acid, gave a black oil, which converted into the nitrate and purified, was proved to have the composition $C_{13}H_{13}N$ or $C_{13}H_{11}NH_2$, a primary amine. Its nitrate, sulphate, and chloride crystallize well. Farther investigation showed it probably to be tolyl-phenyl-amine, $(C_7H_6.C_6H_5.)NH_2$.—*Ber. Berl. Chem. Ges.*, viii, 968, July, 1875. G. F. B.

9. *Viscosity of Saline Solutions.*—M. A. SPRUNG has repeated the experiments of Poiseuille to determine the relation of the viscosity of liquids to their temperature and chemical composition. A volume of 21·15 cms.³ of the liquid was forced through a capillary tube 300 mms. long, and ·46 mms. in diameter, under a pressure of 158 cms. of water. Observations were made with solutions of chloride of ammonium of five different strengths, at intervals of temperature of 5°, from 0° to 60°. A graphical representation shows that the curve of viscosity of the liquid cuts that of water at a temperature as much greater as the solution is stronger, and that at low temperatures the viscosity is less, at high temperatures greater, than that of water. The same result was shown by eight other salts.

By varying the acid it appears that salts of potash, soda and ammonia arrange themselves in the following order with the acids: H_2SO_4, HCl, HNO_3, $HClO_3$, HB_r and HI. In each of the three series the viscosity diminishes from sulphuric acid to iodhydric acid. The acids remaining the same, these salts stand in the order $NaOH$, KOH and NH_4OH, in which the soda salts flow most slowly and the ammonia salts most rapidly. Sulphate of ammonia, however, flows more slowly than sulphate of potash.

If we compare the velocity of flow, of salts of similar constitution, we find that at all temperatures the viscosity of the solution is as much greater with the same base as the molecular weight of the acid is less, and with the same acid as the molecular weight of the base is less.

The viscosity of the same solution of sulphate of oxide of chromium is different according as the salt belongs to the violet or green modification, being greater in the first case than in the second.—*Bib. Univ.*, [illegible], 152. E. C. P.

10. *Photographic Irradiation.*—Capt. ABNEY states that the commonly received view, that the increase in the apparent size of the image of a luminous object when photographed, is due to simple reflection from the back of the plate, is quite untenable. If examined under a microscope, it will be seen that the film consists of minute particles separated by considerable distances from one

another. Their diameter is several times the length of a wave of light, and hence we may treat the question as a case of simple geometrical reflection. Computing by Fresnel's formula the amount of light reflected by the collodion and glass at various angles, we find the maximum amount of light would fall at a distance $2t \cot v$, in which t is the thickness of the glass, and v the critical angle. On development, therefore, a ring might be formed around the image with this distance as a radius, and shading off more abruptly inside than outside. To test these results an image of the sun was formed by a lens of 6″ focus on a plate ·12″ thick. A well defined annulus was formed shaded as described above. With a plate of double thickness, the mean diameter of the annulus was doubled. Two plates were then employed separated by a thin card. A ring was formed on the first plate and a diffused image on the second. A measurement of the intensities agreed closely with the result of theory. Holes and slits were cut in platinum foil, placed on a dry plate and exposed directly to sunlight. Rings were obtained in one case, and parallel lines joined by semi-circles in the other, showing that the effect is not due to the lens of the camera.

Three methods suggest themselves for diminishing irradiation: first, to coat the back of the plate with some non-actinic color; secondly, to increase the opacity of the film; thirdly, to connect the particles of bromo-iodide of silver with a body of as nearly as possible the same density. The first is the usual method adopted by photographers in dry plate processes. This diminishes the irradiation from the back of the plate, but does not completely eliminate it, as will be understood when the nature of the resulting reflection is considered. The second method is easily carried out, and is more effective than the first. With albumen preservative particularly, the amount of irradiation is reduced materially, even though the film appears nearly transparent.—*Phil. Mag.*, l, 46.
E. C. P.

11. *Conical Refraction.*—M. NODOT has endeavored to find a substitute for the crystal of arragonite commonly employed to show the phenomena of double refraction. The rarity of crystals of sufficient thickness of this substance, has led many physicists to improve the optical conditions so as to enlarge the angle of the exterior cone; but the field is still open, to find natural or artificial crystals capable of rivaling arragonite in specific refractive energy, thickness and transparency. Judging by the values of the three indices of numerous biaxial crystals, arragonite will be the most favorable mineral; but chemical substances are so numerous that we may hope to find crystals superior in these respects.

Three substances appear capable of replacing arragonite, sugar, bichromate of potassium and tartaric acid. The method of cutting the two first requires no trial, for a natural face of the sugur and a cleavage face of the bichromate are normal to one of the optical axes. For tartaric acid it is not the same, and the direction of

the faces through which we shall see one of the axes must be found by trial. We succeed easily by employing an Amici's microscope and are recompensed by the result, as crystals of equal thickness give cones twice as open as those of arragonite.—*Journ. Phys*, iv, 166. E. C. P.

12. *Dielectric Capacity of Gases.*—M. L. Boltzmann has endeavored to determine this constant experimentally for gases, in order to determine its probable important relation to the index of refraction. According to the electromagnetic theory of light, of Maxwell, the square root of the dielectric capacity of a transparent medium should be equal to the index of refraction for rays of large wave-length. The capacity was determined by a condenser whose plates were separated by the gases to be tested, the potential being measured by a Kirchhoff's lecture electrometer, and a battery of 300 small Daniel cells being employed.

In the following table the first column gives the name of the gas, the second the square root of the dielectric constant, and the third the index of refraction:

Gas.	$\sqrt{k}$.	n.
Air	1·000295	1·000294
Carbonic acid	1·000473	1·000449
Hydrogen	1·000132	1·000138
Carbonic oxide	1·000345	1·000340
Nitrous oxide	1·000497	1·000503
Olefiant gas	1·000656	1·000678
Marsh gas	1·000472	1·000443

—*Pogg. Annal.*, clv, 403. E. C. P.

13. *The human body rendered luminous by Phosphuretted Hydrogen.*—Dr. Geo. Maclean of Princeton, in a private communication to the editors, says:

"Several years ago, after spending a portion of the day in experimenting with this gas (PH_3) prepared from phosphorus and solution of potash, on retiring to bed I found my body quite luminous, from a glow like that of phosphorus exposure to the air. Either some of the gas escaping combustion, or the product of its burning must have been absorbed into the system, and the phosphorus afterwards separated at the surface have there undergone eremecausis. I was conscious of no feeling that could be attributed to it, nor was my health apparently in any way affected by it."

Probably a repetition of the trial would reproduce the results observed by Dr. Maclean, which have apparently escaped notice heretofore because unsought.

II. Geology and Natural History.

1. *Pseudomorphism and Metamorphism: a correction;* by James D. Dana.—In my notice of Mr. Hunt's Essays in this Journal, volume ix (the number for Feb., 1875), I say, on page 109: "With the exception of the year 1858, I have never held

nor taught that "metamorphism is pseudomorphism on a broad scale." I would here correct the statement by dropping the exception, so as to make it read simply—

"I have never held that metamorphism is pseudomorphism on a broad scale."

When the sentence on page 109 was written I had the strongest personal conviction that I had never entertained this view as a broad general principle, notwithstanding the fact that the sentence stands in a book-notice of mine in this Journal for 1858. For, in 1871, when I first knew that the doctrine was attributed to me, I had no recollection of the sentence, or of passing through such a phase of belief. In addition, my manuscript lectures, which were written out in full for my geological course in 1854, and which were delivered in 1858, as they had been before and were subsequently, do not contain such a principle, any more than does my Manual of Geology, published in 1862, in which those lectures were embodied.

I can refer now to published evidence that the broad principle was never in my mind; and this evidence is afforded by the book-notice (xxv, 445, 1858) which contains the statement. I there—after expressing my confidence in Bischof's views respecting the "agency of alkaline silicates in pseudomorphism and metamorphism," and a reference to papers in volumes xlv, xlvii and xlviii (1843–1845) of this Journal, where I had advocated them—say as follows (the words in italics are those to which attention is directed):

"*On page 92 of the same paper* [that of vol. xlviii, 1845] metamorphism is spoken of as pseudomorphism on a broad scale."

The expression here cited certainly implies that the doctrine referred to had been taught by me as early as 1845. But on the page referred to there is no such general statement, in fact no general statement on the subject. Only the case of magnesian silicates is mentioned, besides that of silica;* and such silicates I have ever regarded as affording examples of pseudomorphism on a broad scale.† The introduction of an omitted word, so as to make the sentence read—

* The paragraph on page 92 is as follows:

"The importance of these discussions [on pseudomorphism] is not to be measured by the length of the catalogue of pseudomorphs. The same process that has altered a few crystals to quartz has distributed silex to fossils without number scattered through rocks of all ages. The same causes that have originated the steatitic scapolites occasionally picked out of the rocks have given magnesia to whole rock formations and altered throughout their physical and chemical characters. If it be true that the crystals of serpentine are pseudomorphous crystals altered from chrysolite, it is true also, as Breithaupt has suggested, that the beds of serpentine containing them are likewise altered, although often covering square leagues in extent. The beds of steatite, the still more extensive talcose formations, contain everywhere evidence of the same agents. The deposits of the so-called Rensselaerite [a variety of the magnesian mineral talc] in Northern New York are other examples of the widely extended influence of the pseudomorphic agencies."

† The "extensive talcose formations" are now excepted, as they have been proved not to be magnesian or talcose.

"On page 92 of the same paper, metamorphism is spoken of as *sometimes* pseudomorphism on a broad scale"—
places it in harmony with my knowledge of my own scientific opinions and the statements in my various mineralogical and geological writings from the first to the last.

2. *On Triarthrus Beckii, supposed to have been found in a boulder in the Connecticut Valley;* by W. W. Dodge. (Letter to J. D. Dana, dated Oct. 22, 1873.)—Having seen last evening, in the October number of the American Journal of Science, the statement of your views there presented as to the age of the "Taconic" rocks, I communicate the following circumstance for what it is worth.

I saw recently in a friend's collection a cast labelled "*Triarthrus*—Connecticut Valley." The collector of the cabinet in which I found it died some years ago, and the present possessor can give no information as to the original. This may be from some well-known locality of whose existence I am ignorant, but as I saw at the same time numerous rock specimens labelled as from various towns in Western Massachusetts, I am inclined to think the cast is from a specimen owned by some friend to whom I have not access; and if really found in the Connecticut Valley, probably an erratic.

From what I have observed as to the distance at which boulders are usually found from the place where the rock was *in situ*, the presence of this fossil anywhere in the Connecticut Valley seems to me interesting.

3. *Forms and Origin of the Lead and Zinc Deposits of Southwestern Missouri;* by Adolf Schmidt. (Trans. St. Louis Acad. Sci.)—The following is an abstract of this important paper:

These deposits are mainly in the Keokuk group (Subcarboniferous)—a group consisting of thin-bedded chert, or of limestone, or of chert and limestone interstratified, or of a calcareous chert called *silico-calcite*. The rocks are much altered and fissured and partly rendered magnesian, in the vicinity of the ores, and the cavities containing the ores appear to have been made when these alterations took place.

The lead and zinc ores of the "runs"—deposits of one horizontal direction not over 5,000 feet in height and width—are always associated with dolomite, and were evidently formed along fissures in a layer of limestone limited above and below by a chert layer, the rock adjoining which had been dolomized by "solutions of bicarbonate of magnesia;" the rock became cracked at the same time from the accompanying diminution of volume and made spaces for the ores. Crystals of galena isolated in the dolomite show that part at least of it was deposited in the rock "while the latter was in a magmatic condition."

In another kind of deposits called "openings," the ores occupy spaces which extend from a chert bed downward, but not through the limestone layer; they show no evidence of origin about vertical fissures, but rather from horizontal openings below a chert bed.

issured chert beds are impregnated with lead and zinc
itly sulphides—in the vicinity of the runs and openings,
me.
another variety of deposit, common in the Joplin dis-
na occurs in loose accumulations of broken chert; and
Joplin creek valley the accumulations have a depth ex-
0 feet. The ore appears to have been formed in the fis-
the chert beds, and, afterward, the chert beds were
through undermining by the removal of the limestone.
na extends into the masses of chert and sometimes also
ized on their surfaces, as if its deposition had commenced
breaking up of the chert but was continued during its

re also seams and crystals of galena and blende imbedded,
ing pockets, in quartzyte, a gray to brownish and often
is variety. The quartzyte in such cases contains also
crystals of dolomite; and the cavities left by the removal
lomite are often filled with carbonate of lead or silicate

various deposits have evidently been very slowly formed
long period of time, and the larger part after the partial
ion of the beds along vertical and horizontal fissures,
ng the spaces for the ores. There are no true veins.
s of rock in which the ores occur lie only from 40 to 120
the surface. Whether lead deposits exist below has
ascertained. Exploration thus far is unfavorable to it.
boniferous Conifers.—Little attention seems as yet to
given to the remains of Coniferous trees found in the
rous rocks of the United States. In Nova Scotia several
e known, and are to some extent characteristic of defi-
zons. In the Carboniferous sandstones of the United
h remains seem to be frequent; but I have seen no de-
ount of them, and the only well characterized specimens
e come into my hands are portions of two trees from
lly sent to me by Dr. Newberry, and a very finely pre-
agment from Mazon, Grundy Co., Illinois. Both of
w the characteristic structure of *Dadoxylon* (Unger),
xylon of Schimper's recent work, and are closely allied
teriarium, the common species of the upper and middle
ations of Nova Scotia. The specimen from Illinois is
identical with that species. One of these from Ohio
some peculiarities in the structure of the medullary rays,
y indicate a distinct species.
bject is deserving of the attention of microscopists in the
icts, as there can be little doubt that several interesting
main to be discovered, and other kinds of structures; as
le the curious *Dictyoxylon* of Williamson, found also in
tia, would very possibly reward patient slicing of trunks
structure.
evonian has also treasures of the same kind. In the

United States it has already afforded *Dadoxylon Halli* from New York, and *D. Newberryi* from Ohio, besides the curious *Ormoxylon Erianium*. No doubt other species remain to be discovered, especially in the Upper and Middle Devonian.

The writer of this note would willingly correspond with any one engaged in such researches, as he has now under examination a number of specimens from different parts of British America, and would be glad to have opportunities of comparison with those of the United States. J. W. DAWSON.

McGill College, Montreal.

5. *Fossil Trees of Craigleith Quarry, Scotland.*—Six trunks of large trees have been obtained at Craigleith quarry since 1826. The largest, 36 feet long and 12 to 14 feet in girth, has been taken to the British Museum, and is to be set up erect there. Another is nearly 30 feet long and has been removed to the Botanic Garden. The trees were Conifers. The surface of each is bituminous coal, varying from one-twentieth of an inch in thickness to two inches. The trunks inside of this coaly exterior consist of carbonate of lime, carbonate of magnesia, carbonate of iron and free carbon in varying proportions. The coaly exterior is attributed, by Sir R. Christison, to bitumen passing to the surface as the destructive distillation of the wood was going on within.—*Proc. Roy. Soc., Edinburgh*, Jan., 1874.

6. *Volcanic History of Ireland*; by Prof. EDW. J. HULL (Roy. Soc., Ireland, vol. iv, part I).—Professor Hull describes as of *Lower Silurian* age, younger than Cambrian, sheets of "felstones" and porphyries of Wicklow, Wexford and Waterford, accompanied by beds of ash and volcanic breccia, interstratified with Lower Silurian slates and grits; also similar beds in the valley of the Boyne which become less frequent in the districts of Down, Armagh and Cavan. They are the representatives of the felstones and porphyries of North Wales, described by Sedgwick, Murchison and Ramsay, and those of Cumberland.

The Irish *Upper Silurian* contains igneous beds in the mountainous region of West Mayo and Galway; felstones, etc., along the western shores of Lough Mask; beds of ash, volcanic conglomerate and some of trap on the Promontory of Dingle, the thickness, according to Jukes, 2,500 feet, and interstratified with fossiliferous Wenlock beds.

The Irish *Devonian*, in the Killarney Mountains south of Lough Guitane, where a bold rock, 1490 feet high, a mass of columnar felstone, "indicates the position of an old 'neck' or volcanic throat, from either side of which, for considerable distances, beds of feldspathic ash and conglomerate, with large 'balls' of felstone, often hollow in the center, which were probably bombs shot out of the vent at various stages of the eruption." These beds of ash re-occur at Lough Garagarry, Lough Managh and the Devil's Punchbowl, and rise into the summit of Crohane (2,162 feet) and the southern slopes of Killeen Mountain. To the south, there is another district containing cotemporaneous trap rocks at the

mouth of Kenmare River. The shores of Lough Kay and Valentia Harbor are "another volcanic center of eruption during the period," beds of felstone, greenstone, ashes and conglomerates being there associated with those of the Old Red Sandstone and intersecting the latter in dikes.

In the *Lower Carboniferous*, occur the trap rocks of the Limerick basin, cotemporaneous with the toad-stones of Derbyshire, the trap and porphyrite ashes of the central valley of Scotland forming the Kilpatrick, Campsie and Dalry Hills. These Limerick trap rocks are of two times of eruption, the earlier being the most important. The trap is chloritic and contains chrysolite. Another district is that at the entrance of Bantry Bay, where the rocks are felstones, greenstones, beds of ash, breccia and conglomerate.

No volcanic ejections of the Permian or of the Mesozoic periods occur. The next in age and last are those of the Miocene Tertiary. They occur over the area of northeastern Ireland, and extend thence to the west of Scotland and the inner Hebrides. The area in Ireland is 2,200 to 2,300 square miles. These rocks are briefly described, from an article by Professor Hull, in the last volume of this Journal, at page 147.

7. *Asphaltic Coal from the shale of the Huron River, Ohio*; by Prof. A. R. Leeds.—In the number of the Annals of the Lyceum of Natural History of New York for June, Professor Leeds describes a coaly substance from Ohio, resembling much the asphaltic coal or albertite of New Brunswick. The seam averages two inches; and it is traversed by innumerable sheets of sulphate of baryta.

Dr. J. S. Newberry adds a note to the paper stating that there are many localities of similar material in Ohio and Kentucky; and that it occurs in fissures of the Huron shale and was formed from distilled petroleum, like the albertite and grahamite. He observes that this shale, "which is the equivalent of the Portage group of the New York geologists," contains throughout from 10 to 25 per cent of carbonaceous matter, and is the source whence most of the oil is derived both in Pennsylvania and Ohio.

8. *Eruption of Tridimitic Ashes.*—Dr. A. Baltzer, of Zurich, has announced that the Island Volcano, one of the Lipari group, ejected, on the 7th of September, 1873, a whitish ashes for three hours, which formed a deposit over the interior of the island, in some parts three to four centimeters deep, which consisted of silica in the state called tridimite. He found the material to agree with that species in specific gravity, degree of solubility in alkali, action of polarized light and other respects. His announcement was made before the Society of Natural History of Zurich, on the 4th of January, 1875.—*R. Com. Geol. d'Italia*, 1875, 197.

9. *Exploration of the Colorado River of the West, and its Tributaries*, explored in 1869 to 1872 under the direction of the Secretary of the Smithsonian Institution; by Prof. J. W. Powell. 292 pages, 4to, with many plates, 8 maps.—The Smithsonian Institution has shown, by this volume of Professor Powell, that

Congress did well in placing this exploration of the Colorado under its direction. The volume has been, in part, foreshadowed by the magnificent photographs of the Colorado region, by the artist of the expedition, which have been widely distributed through the country. But the descriptions of Professor Powell, and the new birds,eye views and sections inserted alongside of the photographs which are reproduced in admirable style, have added ten-fold to the instruction from the latter. The work is to a large extent a treatise on denudation, or the making of valleys—and of mountain forms, too, by circumdenudation—and never was the subject more appropriately and grandly illustrated. The author divides the valleys of the region into two classes: 1st, the *Transverse*, running across the strike, and, 2d, the *Longitudinal*, running with the strike. Under each class he makes three kinds. Of *Transverse:* (*a*) those which pass through a fold, the *diaclinal;* (*b*) those running in the direction of the dip, the *cataclinal;* (*c*) those running against the dip, the *anaclinal.* Of *Longitudinal:* (A) Those which follow anticlinal axes, the *anticlinal;* (B) those which follow synclinal axes, the *synclinal;* and (C) those which follow the direction of the strike between the axes of the fold, the *monoclinal.* The subject of faults in the Colorado region is fully illustrated. Many readers of Professor Powell's article in vol. v, of this Journal (p. 456, 1873) were no doubt unsatisfied for the want of sections. These are here fully supplied.

The volume also gives much information on the Indians of the Colorado region. It closes with a chapter of 65 pages on the genera *Geomys* and *Thomomys* by Dr. Elliott Coues, U. S. A. There is also an Addendum on the Salamander of Florida (*Geomys tuza*), by Prof. G. Brown Goode, the direct connection of which with the subject of Professor Powell's Report is not apparent to us.

10. *Report of the Geological Survey of Ohio.* Vol. II, *Geology and Paleontology.* Part I, GEOLOGY. Officers of the Survey, J. S. NEWBERRY, Chief Geologist; E. B. ANDREWS and EDWARD ORTON, Assistant Geologists; F. G. WORMLEY, Chemist; F. B. MEEK, Paleontologist. 702 pp. 8vo, with plates, wood-cuts, and colored geological county maps. Columbus, Ohio. Published by authority of the Legislature of Ohio.—The survey, of which this volume is one of the series of Reports in course of publication, was carried forward during the years 1869 to 1874. The volume just issued is the second on the Geology of the State, although this might not be inferred from the ambiguous title-page. The first was issued two years since and is noticed in this Journal in vol. vi. The new volume commences with chapter xxx. The title-pages of the two volumes are intended to indicate—not "volume I, Geology and Paleontology, Part I, Geology," and "volume II, Geology and Paleontology, Part I, Geology," as they read—but Part I, Geology, vol. I, and Part. I, Geology, vol. II. A third volume, vol. III, will finish the Part I, Geology; and two volumes more will complete Part II, Paleontology, volume I having been published in 1873.

The Reports, as we have before said, are very valuable contributions to geological science, and as important to the economical interests of the State The paleontological volumes, if published with all the plates, according to the plan proposed, will redound to the honor of the State, and contribute to the progress of knowledge throughout it, if bringing no return to its treasury.

The present volume commences with a chapter on the Quaternary, or, as it is here called, Surface Geology, by Dr. Newberry —a chapter which has been noticed in the last volume of this Journal. Dr. Newberry has, next, valuable chapters on the Carboniferous System of Ohio and on the Geology of Erie and Lorain Counties. The succeeding chapters on Ottawa, Crawford, Morrow, Delaware, Van West, Union, Paulding, Hardin, Hancock, Wood, Putnam, Allen, Anglaize, Mercer, Henry and Defiance Counties are by N. H. Winchell; those on the Surface Geology of Southeastern Ohio, on Washington, Noble, Guernsey (southern half), Belmont (southern half), Monroe, Pickaway and Fairfield Counties, by E. B. Andrews, who has devoted much time to the coal formation; and those on Pike, Ross, and Greene Counties, concluding the volume, by Edward Orton.

The facts in these Reports have in part appeared in the Annual Reports published in the course of the survey, and have been the subjects of notices in this Journal. Without further discussion of their contents, we repeat that they are all worthy of thorough study. The geological maps of the counties, inserted in the volume, are well colored.

11. *Sixth Annual Report of the Geological Survey of Indiana made during the year* 1874; by E. T. Cox, State Geologist; assisted by Prof. JOHN COLLETT, Prof. W. W. BORDEN and Dr. G. M. LEVETTE. 288 pp. 8vo, with maps and plates.—This volume contains a Report by the State Geologist, Mr. Cox, on the Quaternary of Indiana, some of its economical products, its Indian antiquities, and the Geology of Jackson County, with a Geological map; a Report on the Geology of Brown County, with a map, by Prof. Collett; on the Geology of Scott and Jefferson Counties, with maps, by Prof. Borden; on the Sisco of Lake Tippecanoe and its relatives, by Prof. D. S. Jordan, M.D., with a wood-cut of *Argyrosomus sisco* Jordan; a synopsis of the genera of Fishes to be looked for in Illinois, by Prof. Jordan; and a partial list of the Flora of Jefferson Co., by J. M. Coulter.

Mr. Cox gives the following list of fossil shells found in the lœss near New Harmony: *Macrocyclis concava* Say, *Zonites indentatus* Say, *Patula perspectiva* Say, *Helix lineata* Say, *H. labyrinthica* Say, *H. hirsuta* Say, *H. monodon* Rack., id. var. *fraterna*, *Punctum minutissimum* Lea, *Succinea elongata* Say, *Pupa armifera* Say, *Helicina occulta* Say, *Cyclostoma lapidaria* Say. The upper surface of the lœss is 165 feet above the Wabash river in Posey Co., and in Perry Co., on the Ohio, about 200 feet.

The "Black shale," the formation which overlies the Corniferous limestone, has afforded Prof. Borden, at Lexington in Scott

Co., the following fossils—identified by R. P. Whitfield: *Leiorhynchus quadricostata* Hall, *Chonetes lepida* Hall, *Tentaculites fissurella* Hall, a fragment of a *Cardiola* near *C. radians*. The *Leiorhynchus* is a Genesee shale species; the *Tentaculites* is found as well in the Marcellus and Hamilton beds; the *Chonetes* belongs to the Hamilton and possibly also to the Genesee; while the *Cardiola* is a Devonian genus having species in the Upper Helderberg and Hamilton; which facts appear to establish the equivalency of the New Albany Black Shale and the Genesee shale; while the Goniatite shale, which rests upon it, represents the Kinderhook group (Subcarboniferous) of Illinois.

Kaolin, or white porcelain clay, occupying "pockets" in the Carboniferous rocks of Pope County, has been long known under the name of Golconda clay. In Lawrence County the clay constitutes a bed interstratified with the Carboniferous rocks, which is five to six feet thick (one-third pure white) and has a wide extent. It is underlaid by a bed of limonite five feet and less in thickness. It lies beneath the Millstone grit and seems to correspond to an upper member of the Archimedes limestone. The Kaolin is in part (A) Snow-white and pulverulent; in part (B) white to purplish-brown, and cutting like putty; and (C) in concretionary masses of a pea-green color fading in the light, with an unctuous feel. It is called *Indianaite* by Mr. Cox. The kaolin contains masses of allophane of a transparent emerald-green color, one specimen of which afforded Dr. J. Lawrence Smith: Silica 20 per cent, alumina 40, water 40. All degrees of gradation exist between the allophane and kaolin.

Analysis of the kaolin afforded—

	$\ddot{S}i$	$\ddot{\bar{A}}l$	$\bar{F}e$	$\bar{M}n$	$\dot{C}a, \dot{M}g$	$\dot{H}$
Var. A	45·90	40·34	—	—	—	13·26
Var. B	47·05	37·14	*tr.*	·03	·03	15·55
Var. C	47·13	36·76	*tr.*	—	·04	15·13
Golconda	42·28	43·05	—	—	*tr.*	14·66

The several County Reports with their maps present much valuable matter on the Quaternary, Devonian, Carboniferous and Subcarboniferous rocks. Prof. Collett states that the boulder clay of Northern Illinois has its southern limit in the northern part of Brown Co., with little thickness, but in Northern Illinois it becomes 150 to 250 feet thick; and he adds some facts respecting erosions by the waters from the melting glacier Various sections illustrating the relations of the Black Shale to the other rocks are given by Professor Borden, whose discoveries in it are mentioned above.

12. *The Geological and Natural History Survey of Minnesota: The Third Annual Report*, for the year 1874; by N. H Winchell, State Geologist. Submitted to the President of the University of Minnesota, Dec. 31, 1874.—Prof. Winchell, in this Report, treats of the Geology of Freeborn and Mower Counties. Of Freeborn County Mr. Winchell remarks, "There is not a natural exposure of the underlying rock" and "hence the details of its geological structure are wholly unknown." The field is

still not a barren one; for the surface is covered with the drift, and the material of which it consists affords some evidence of the rocks below; and, besides, a shaft has struck the Cretaceous in the northwestern portion of the county. It is inferred that the Cretaceous extends north and south across the west end of the county. The average thickness of the drift in Freeborn County is stated to be not far from 100 feet. A figure is given illustrating the flow-and-plunge structure of the sand and gravel at Albert-Lea. Clay for brick-making is obtained near this place about five feet below the surface. Clay, from the drift formation, is also found at Geneva.

Mower County also is buried in drift, but not to the concealing of all rock exposures. As elsewhere in the northwest, the drift-made soils are of the very best kind. The drift material is a "hard-pan clay" light in color for 10 to 15 feet, and below this usually bluish. It contains gravel and boulders, some of them of granite and very large. At Windom and LeRoy this drift overlies a peat bed.

The Lower Cretaceous underlies the western portion of the county; how far east it extends is unknown. The Cretaceous beds at Austin have afforded fossil leaves—one kind related to *Ficus primordialis* Hr., and another a *Sequoia*. Explorations for coal in these counties have obtained nothing that promises success. Lignite is found to encourage the search, but, Mr. Winchell observes, "after the tests that have already been made it can be pretty confidently stated that the lignites are at present of no economical value."

13. *Note on Lignite in the Cretaceous of Minnesota;* by N. H. WINCHELL. (From a letter to J. D. Dana, dated Minneapolis, Minn., Sept. 2, 1875).—An interesting discovery of lignite in the extreme northern portion of Minnesota has just been made. Explorations have been carried on during the summer by private parties in search of coal, and a hundred pounds of what was taken for coal were brought to Duluth from a point between Vermilion and Rainy lakes.

Similar exploration has revealed the lignites of the Cretaceous at a number of other points in Minnesota, extending from near the Iowa state line to the central portion of the state. Mr. Kloos has given an account of a "Cretaceous basin in the Sauk Valley" in this Journal, and Mr. Meek identifies it as the *Fort Benton* by the few fossils that were gathered. Inferentially the Cretaceous has been extended over the most of Minnesota, and even into the State of Michigan (First Annual Report of the Geological Survey of Minnesota, 1872), but this discovery not only shows that the Sauk Valley is probably not an isolated "basin," but also that the Cretaceous beds did extend, prior to the drift, at least, if they do not now, over the entire state from north to south. I have an account also of a probable Cretaceous outcrop in the state of Winconsin from Prof. Frank H. Bradley, but it has not been identified authentically.

14. *Note on the Age of the Cretaceous of Vancouver Island and Oregon;* by W. M. Gabb. (From a letter to J. D. Dana, dated Philadelphia, Sept. 5, 1875.)—In the April Number of this Journal, p. 318, there is a note by Mr. Selwyn with reference to the age of the Nanaimo coal mines. While fully endorsing the opinion there expressed, it may be worth while to call attention to the fact that the same opinions were put on record in the Reports of the California Geological Survey, both by Prof. Whitney and myself, as much as eight years before the date of the volume of the Canadian Report quoted.

In this connection, I wish to note in the new edition of the "Manual of Geology," p. 466, top of page: The Cretaceous formation is said to occur "in Oregon, east of the Cascade Range (Marsh)," thereby giving to Prof. Marsh the credit of the first announcement.

Without wishing to disparage the excellent work done by that paleontologist, you have inadvertently done me an injustice, to which I call your attention. See Palæontology of California, vol. 2, p. 181, foot-note.

15. *Sub-Wealden Exploration.*—The Sub-Wealden boring has reached a depth of 1,672 feet. It was the opinion of British geologists that Paleozoic rocks would be found at a depth varying from 700 to 1,700 feet. So far, however, the strata are Mesozoic; but the latest fossils give some indications of a Paleozoic rock.—*Nature*, July 29.

16. *Das Elbthalgebirge in Sachsen.* I Theil, 8 Lief., and II Theil, 6 Lief. (Cassel, Th. Fischer.) This great work, by Dr. Geinitz, has been brought to a close by the publication of the two numbers here announced—the first (pp. 277 to 320) closing his descriptions of the fossils of the Lower Quader (Upper Green Sand of the Middle Cretaceous), and the second (pp. 199 to 246) of those of the Middle and Upper Quader (Upper Cretaceous). The lithographic illustrations, drawn partly by E. Fischer, and in part by Miss Elise Geinitz, daughter of the author, extend to 67 4to plates for the former and 46 for the latter, and are excellent; they include figures of species of Sponges (10½ plates) Foraminifers, Radiates (18½ plates), Bryozoans, Brachiopods, Conchifers, Gasteropods, Cephalopods, Worms, Crustaceans, Fishes, Reptiles and Plants. The remains of the Vertebrates of the Lower Quader, described and illustrated in Part I, include species of the genera of Sharks, *Oxyrhina*, *Otodus*, *Lamna*, *Scylliodus*, *Corax*, *Acrodus*, *Ptychodus*; of Ganoids, *Pycnodus*; and of Reptiles, of the genera, *Plesiosaurus* and *Leiodon*. The remains of Fishes, illustrated in Part II, include teeth of Sharks of the genera, *Oxyrhina*, *Lamna*, *Otodus*, *Notidanus*, *Corax*, *Ptychodus* and *Spinax*; remains of *Chimæra Agassizi* Buckl. and *C. Mantelli* Buckl.; under Ganoids, species of *Pycnodus*, *Hemicyclus*, etc.; under Ctenoids, *Beryx ornatus* Ag., *Hypsodon Lewesiensis* Ag., etc.; under Cycloids, *Cladocyclus*, *Strehlensis* Gein., *Saurocephalus lanciformis* Harlan, *S.? dispar* Hébert, *Enchodus halocyon* Ag., *Osmeroides Lewesiensis* Mant., *O. divaricatus* Gein., and *Cyclo-*

is Agassizi Gein.; and the Reptiles comprise the species *Plesiurus Bernardi* Owen, *Polyptychodon interruptus* Owen, *Cheia Carusiana* Gein.

The work is full in its descriptions and synonymy, and many of species have been first made known by Dr. Geinitz.

7. *Paleontological Cabinet of Prof. James Hall.*—Professor ll's extensive collection of fossils has been purchased for the ntral Park Museum, New York. The price reported to have n stipulated is $65,000.

8. *On two new varieties of Vermiculites;* by Prof. J. P. Cooke l Mr. F. A. Gooch. (Proc. Amer. Acad. Sci., of May 11, '5).—In this paper, which may be regarded as supplementary Prof. Cooke's elaborate memoir published early in 1874, the hor describes two new varieties of vermiculites, one from rni, Delaware Co., Pa., and another from Pelham, Massachusetts. means of careful experiments, the loss of water was ascertained er air-drying, and at 100° C., 300° C. and red heat. The lyses obtained and those previously made of other vermiculites, discussed, and the following important conclusions reached.

. That all the vermiculites are unisilicates.

2. That these minerals combine with water in several definite portions—sustaining Prof. Cooke's former statement that the ter in the vermiculites is water of crystallization.

3. That they may be reduced to the condition expressed by the mic ratio (oxygen-ratio) for the silica, oxides and water, 2 : 2 : 1, ich is therefore taken as the normal ratio.

4. That the only essential difference between the different ieties of vermiculites is in the ratio between the sesquioxide l protoxide bases.

The atomic ratios obtained for the air-dried, dried at 100°, and ed at 300°, specimens, are respectively, for

Hallite	4 : 4 : 3,	4 : 4 : 2½,	4 . 4 : 2
Pelhamite	4 : 4 : 4,	4 : 4 : 2,	4 : 4 : 1
Jefferisite	4 : 4 . 4,	4 : 4 : 2,	4 : 4 : 1

e Lerni mineral gave, dried at 100° C., the ratio 2 : 2 : 1 4 : 4 : 2); and the analysis afforded (mean of results)

$\ddot{S}i$ 38·03, $\ddot{\bar{A}}l$ 12·93, $\ddot{\bar{F}}e$ 7·02, $\dot{F}e$ 0·50, $\dot{M}g$ 29·64, $\dot{H}$ 11·68=99·80.

9. *Dana's System of Mineralogy.*—A new "subedition" of s work—the sixth—has been brought out by the publishers, ssrs. Wiley & Son of New York; in other words, copies have n struck off from the plates *after making a number of corrections* as in the case of the other "subeditions." Moreover the ies of this subedition contain the two Appendixes to the work he first by Professor Brush, and the second by Mr. E. S. Dana dding thus 28 pages to the 828 of the original volume.

10. *Hematococcus lacustris, &c.*—Some account of researches on this microscopic plant, and upon the foundations of a natl classification of the Chlorosporous Algæ, are just published Rostafinski—lately a pupil of DeBary—in the Memoirs of the ademy of Sciences of Cherbourg (tom. xix, pp. 137–154, 8vo, 75). The identity of *Protococcus*, *Hæmatococcus*, or *Chlamydi-*

coccus nivalis and *pluvialis* is made out; at least it is shown that the latter can live upon snow and ice, and that the development is identical. For the generic name of the *Red-snow* plant, &c. Agardh's name of *Hæmatococcus* is preferred, on good grounds: the specific name adopted is *lacustris*, Girod-Chantrans having well investigated the plant and figured and described it, under the name of *Volvox lacustris*, so long ago as the end of the last and the beginning of the present century (1797, 1802). *Hæmatococcus* propagates by two kinds of zoospores; i. e. sometimes by large and ordinary ones, resulting from the division of the contents of the cell or plant into four daughter-cells, each of which is transformed into a zoospore of somewhat complicated structure; while other individuals transform their contents into about 32 microzoospores. The development of both kinds of zoospores into the plant has been observed by Rostafinski. The development is non-sexual. Velter's supposed discovery of the copulation of the large zoospores is discredited and explained away. Rostafinski concludes that *Hæmatococcus* is devoid of sexual reproduction. Following up Decaisne's early hint that the reproductive organs of *Algæ* should furnish the characters for their natural arrangement, he indicates the principal groups or tribes of the *Chlorosporeæ* which have thus far been made out, by DeBary and others, with some re-organization. Thus, after the *Conjugatæ*, in which fecundation takes place by the conjunction of two immobile cells of the same value (i. e. with no distinction of male and female), he proposes to place a parallel tribe, *Isosporeæ*, in which there is a copulation of zoospores, the sex of which is equally indeterminate (*Hydrodictyon*, *Botrydium*, &c.). The third is *Oophoreæ* of DeBary (*Sphæroplea*, *Vaucheria*, *Œdogonium*, &c., to which Rostafinski adds *Volvox* and *Eudorina*; here the fecundation is by antheroroids and oospores. And he is disposed to take *Hæmatococcus* as the type of a fourth tribe, *Agameæ*, propagating non-sexually by spores. A. G.

21. *Catalogue of Plants growing without cultivation within thirty miles of Amherst College*; by EDWARD TUCKERMAN, M.A. and CHARLES FROST, M.A. Amherst, 1875. pp. 98, 8vo.—The Lower Cryptogamia, exclusive of the *Lichenes*, are by Mr. Frost. They fill half the Catalogue. Prof. Tuckerman contributes an interesting preface. The Catalogue bears marks of the scrupulous accuracy and neatness of finish which characterize all of Prof. Tuckerman's work, the simplest, no less than the more elaborate: and the arrangement, typography, and paper, are of corresponding excellence. We venture to correct a correction. We are told at the close to "read *Calystegia Sepium*"; but we prefer to read as it stands in its place "*Calystegia sepium*." Such substantive genitive plurals, not being proper names, surely need no capital initial, nor are they accustomed to have them. A few plants have been detected in the district which would not have been expected and are not before recorded. *Blephilia ciliata* is the most noteworthy of these. We are curious to know how many species this model catalogue contains, and count it an oversight that the number is

not reckoned. A rough and rapid enumeration gives 1066 Phænogamous species, 59 Acrogenous Cryptogamia, 216 Anophytes, 1361 Thallophytes. of which over eleven hundred are Fungi; so that the Cryptogamia amount to 1839.

We may hope that the time is not far distant when we may have Manuals of all our Lower Cryptogamia, beginning with the *Lichenes* by Prof. Tuckerman. A. G.

22. *Serjania Sapindacearum Genus monographice descriptum. Monographie der Sapindaceen-Gattung Serjania*, Von L. Radlkofer. Munich, 1875. pp. 392, 4to. Published by the Royal Bavarian Academy.—To this memoir the quinquennial prize founded by the will of the elder DeCandolle has been awarded, and it well deserves it. It is one of the most elaborate, painstaking, and apparently thorough pieces of monographical work in systematic botany that we have ever seen. Undertaken as it is by one who has proved, at the commencement of his career, his ability for microscopical investigation (when Radlkofer gave the *quietus* to the theory of the origination of the embryo from the pollen-tube), we may hope that an investigation of this kind will not be detrimental to the author's prospects, in a country where it has been the fashion to undervalue everything not microscopical, and even that it may betoken a rising appreciation of systematic botany in Germany. The subject is too technical to call for a detailed review in this Journal. We merely note that 145 species of Serjania are characterized, described, and their synonymy completely exhibited. Nearly all extant materials appear to have been under the author's hands. A. G.

23. *Zur Keimungsgeschichte der Charen*, von A. de Bary.—In the present paper, extracted from the Botanische Zeitung, Prof. De Bary gives a detailed account of the manner in which the prothallus is produced from the spore in the Charæ. That the new *Chara*-plant does not spring directly from the spore was first shown by Pringsheim, who noticed that the plant is a lateral outgrowth from an intermediary filamentous structure, the *vorkeim* (prothallus). De Bary finds that a lenticular portion of the spore projects beyond the mass of the spore from which it is soon separated by a wall. The lenticular portion is then divided into portions, one of which develops into the prothallus proper, while the other becomes what is known as the primary root in *Chara*, although it does not correspond to the structure of the same name in phanerogams. In passing, reference is made to parthenogenesis in *Chara crinita*, which fact is confirmed by De Bary, who finds that female plants isolated in closed glass vessels fruit abundantly. W. G. F.

24. *Description of a new Crustacean from the Water-lime group at Buffalo;* by Aug. R. Grote and W. H. Pitt, (Bulletin of the Buffalo Society of Natural Science, vol. iii, July, 1875.)—The specimen shown exhibits an impression of the ventral surface of a new form of Crustacean allied to *Eurypterus Pterygotus*, for which the name *Eusarcus scorpionis* is proposed. The cephalothoracic portion appears to be separate from the body,

and to be considerably narrower in proportion than in allied forms. The legs are in the same number as in *Eurypterus*. The swimming feet appear to differ by the straighter, less rounded outer margins. In the specimen the rhomboidal plates are not given. From the impressions of the joints of the swimming feet their relative dimension does not seem to accord with *Eurypterus*. The four pair of anterior feet proceed from two elongate oral plates of which the impression is very distinct. The spines of the anterior feet appear to be long, curved, and to have an anterior direction. The absence of chelate appendages to the posterior margin of the feet is particularly noticeable. The first seven broad segments of the abdomen form a large ellipse. There is an evident and remarkable narrowing of the succeeding caudal segments. Of these six appear to be made out on the specimen. The surface of the cast is punctate with scattered triangular impressions. The cast shows a widening of the terminal segment and no traces of a spiniform process are exhibited. This portion of the fossil was imbedded in the matrix, and seems to have been bent downward and outward in the specimen. The greater flexibility of the caudal segments may be inferred from their shape and position. The specimen from which the above description is drawn was found in the Water-lime group at Buffalo, N. Y., in the same bed which has furnished specimens of *Eurypterus lacustris*. The length of the entire specimen is two hundred and fifty millimeters; the greatest width of the body is one hundred and ten millimeters.

"The interest which attaches to this remarkable Crustacean arises from the discovery of a form which may be allowed to be higher than *Eurypterus* and *Pterygotus* from the peculiar differentiation of the body expressed by the narrowness of its cephalothoracic portion, and the sudden constriction of the terminal segments." The article is accompanied by a fine plate.

25. *Bathybius.* Prof. Huxley in connection with the publication of a letter to him from Prof. Wyville Thomson in *Nature* of August 19th, remarks as follows: -Prof. Wyville Thomson further informs me that the best efforts of the *Challenger's* staff have failed to discover *Bathybius* in a fresh state, and that it is seriously suspected that the thing to which I gave the name is little more than sulphate of lime, precipitated in a flocculent state from the seawater by the strong alcohol in which the specimens of the deep-sea soundings which I examined were preserved.

"The strange thing is, that this inorganic precipitate is scarcely to be distinguished from precipitated albumen, and it resembles, perhaps even more closely, the proligerous pellicle on the surface of a putrescent infusion (except in the absence of all moving particles), coloring irregularly but very fully with carmine, running into patches with defined edges, and in every way comporting itself like an organic thing."

Prof. Thomson speaks very guardedly, and does not consider the fate of *Bathybius* to be as yet absolutely decided. But since I am mainly responsible for the mistake, if it be one, of introduc-

ıg this singular substance into the list of living things, I think I ıall err on the right side in attaching even greater weight than e does to the view which he suggests.—*Nature.*

III. Miscellaneous Scientific Intelligence.

1. *American Association.*—The meeting of the Association at)etroit was well attended, and, as the list below shows, many paıers of interest were presented. The address of the retiring ʾresident, Dr. John L. LeConte, is republished in pages 241–256. ʌn excellent address was delivered by Prof. H. A. Newton, Vice ʾresident of the Physical section, on the importance of the Study ıf Mathematics for the student in all branches of science, and .nother, by Dr. J. W. Dawson, before the Geological and Natural Iistory section, presenting some of the difficulties which geology ıppears to place in the way of Darwinism. The Chemical section, ırganized at the preceding meeting, at Hartford, brought together nany chemists.

The next meeting of the Association is to be held at Buffalo. Гhe following officers were appointed for that meeting: President, ʾrof. Wm. B. Rogers; General Secretary, F. C. Mendenhall; /ice President of Section A, Charles A. Young, of Hanover, \. H.; of Section B, Edward S. Morse, of Salem, Mass. F. W. ʾutnam, of Salem, Mass., is Permanent Secretary.

The following is a list of the papers read either in full or by .bstract.

I. *Mathematics, Physics, Astronomy.*

The Solar Atmosphere; S. P. Langley.

Account of the Measurement of a Primary Base Line in the U. S. Coast Survey, ear Atlanta, Ga.; J. E. Hilgard.

Problems in Watson's Coordinates; T. Hill.

Distribution of the Asteroids; D. Kirkwood.

Descriptive Geometry; S. E. Warren.

An Acoustic Method of Measuring the Velocity of Electricty; J. Lovering.

A Systematic Method for indicating the Localities of a County, and rapidly iscovering Places in a Map; J. M. Toner.

Tides of New York Harbor; W. Ferrel.

Algebraic curves expressed in trigonometric equations; H. A. Newton.

Transformation of curves from Algebraic to Transcendental; H. A. Newton.

Geometrical representation of certain Diophantine Problems; H. A. Newton.

Path of Iowa County Meteorite, with exhibition of fragments of the same; Γ. R. Leonard.

A new Meteorological Instrument; J. W. Osborne.

The Relative Intensity of the broken lines of Metallic Spectra; G. F. Barker.

A New Vertical Lantern Galvanometer; G. F. Barker.

On some Inequalities of Long Period in the Moon's Motion; J. N. Stockwell.

Adjustment of the Gregorian Calendar; E. B. Elliott.

The Subsidiary Principle as applied to Coinage and Money account; E. B. ıllıott.

Description of an apparatus for the automatic determination of Atmospheric esistance; G. W. Hough.

Method of exhibiting by Projection the difference in rapidity of transmission f Sound through various Gases; T. C. Mendenhall.

Temperature of two Deep Borings in Indiana; E. T. Cox.

II. *Chemistry.*

On an improvement of Bunsen's method for specific gravities of gases, etc.; T. C. MENDENHALL.

Chemistry of three dimensions; F. W. CLARKE.

On certain new Tungsten compounds; A. R. LEEDS.

On the omission of Dynamical Quantities from Chemical Formulæ; H. F. WALLING

Carbon determinations in Iron and Steel; J. W. LANGLEY.

Comparative determinations of the solubilities of Alkaloids in Crystalline, Amorphous, and Nascent conditions, A. B. PRESCOTT.

Note on Colorado Tellurium; F. W. CLARKE.

On the requisite amount of simple friction of soft iron against cold steel to melt it; B. S. HEDRICK.

On Otto's method of estimating Phosphoric Acid in presence of Iron and Aluminium; S. W. JOHNSON.

Apparatus for fat extraction; S. W. JOHNSON.

Composition of corn fodder and yield per acre; S. W. JOHNSON.

Composition of the Sweet Potato; S. W. JOHNSON.

On Thorpe's method of estimating Nitric Acid; S. W. JOHNSON.

A Convenient Instrument for showing the Absorption of Hydrogen Gas by Palladium; J. L. SMITH.

On Graphitic Oxide as prepared from the Graphites of the Sevier Co. and Dekalb Co. Meteorites, J. L. SMITH.

Notice of an undescribed Meteorite that fell in Wisconsin in 1865; J. L. SMITH.

Exhibition of a large quantity of Cæsium Alum, with some remarks on its Preparation, J. L. SMITH.

On certain precipitates containing Chloride of Silver; F. W. CLARKE.

III. *Geology and Paleontology.*

Geology of the Southern Counties of New York, and particularly of the Catskill Mountain Region; J. HALL.

A comparison between the Northern (or Ohio) and the Southern (or W. Va.) side of the Alleghany Coal Field, E. B. ANDREWS.

New and remarkable Coal-plants from the lower Coal Measures of Ohio, and their typical relations; E. B. ANDREWS.

New specimens of Fossils from Canada; J. W. DAWSON.

Physical Geology of the trap formation of Lake Superior; C. WHITTLESEY.

Physical Geology of the Ohio coal-field; C. WHITTLESEY.

On Ancient Glaciation at Kelley's Island, Ohio; C. WHITTLESEY.

Ancient Peat in the Drift deposits of Minnesota, N. H. WINCHELL.

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On some of the Results of the Geological Survey of Ohio; J. S. NEWBERRY.

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Parallelism of Devonian outcrops in Michigan and Ohio; N. H. WINCHELL.

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IV. *Zoology and Botany.*

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Are Potato Bugs poisonous? A. R. GROTE and A. KAYSER.

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The Locust Plague in America: how to avert it; C. V. RILEY.

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Venation of Leaves of Dragon-Root and Martynia compared; W. J. BEAL.

Additional Observations on the Tarsus and Carpus of Birds; E. S. MORSE.

Distribution of Batrachia and Reptilia of North America; E. D. COPE.

Indications of Descent exhibited by North American Tertiary Mammalia; E. D. COPE.

Protozoan Studies; W. S. BARNARD.

On leading divisions in Recent and Fossil Chitonidæ; P. P. CARPENTER.

A method of Bleaching Wings of Lepidoptera to facilitate the study of their venation; G. DIMMOCK.

Observations on the Development of *Didelphys Virginiana;* W. S. BARNARD.

Membral Myology of *Simia Satyrus* as compared with Man and the higher Apes; W. S. BARNARD.

Demonstration of Locomotion in the Larvæ of Oestridæ; O. S. WESTCOTT.

Periodicity in Vegetation; J. HYATT.

Embryology of the Fresh Water Mussels; W. K. BROOKS.

Some Observations on the Structure and Habits of *Utricularia vulgaris* (Carnivorous? plant); T. B. COMSTOCK.

On hybernation as exhibited in the Striped Gopher; P. R. HOY.

Gestation of Bats; B. G. WILDER.

Affinities and Ancestry of the Existing Sirenia; B. G. WILDER.

Notes on Menobranchus and Menopoma; B. G. WILDER.

Notes on the American Ganoids (*Amia*, *Lepidosteus*, *Acipenser* and *Polyodon*; B. G. WILDER.

Structure and Economy of Lamprey Eels (*Petromyzon*); B. G. WILDER.

The rectal pouch of Sharks and Skates, as perhaps representing the allantois of Air-breathing Vertebrates; B. G. WILDER.

V. *Ethnography and Archæology.*

Fac similes from Nature of Ancient Rock Sculptures in Ohio, with verbal explanations; C. WHITTLESEY.

Recent Mound Explorations at Davenport, Iowa; R. J. FARQUHARSON.

Indian Mounds and Shell-heaps near Pensacola, Florida; G. M. STERNBERG.

Notes on Aboriginal Money of California; L. G. YATES.

The Ancient Men of the Great Lakes; H. GILLMAN.

Ancient Earthworks near Anderson, Ind.; E. T. COX.

Rates of Human Progress; L. H. MORGAN.

Arts of Subsistence; L. H. MORGAN.

Ethnical Periods; L. H. MORGAN.

Mound Explorations in Kent County, Michigan; E. A. STRONG.

Archæological Notes from Wyoming; T. B. COMSTOCK.

2. *Foreign Scientific Associations.*—The meeting of the British Association at Bristol opened on Wednesday, the 25th of August. *Nature*, in the number for the 26th, and several following numbers, contains an extended report of the Proceedings.

The French Association began its session at Nantes on the 19th of August; and the Italian, at Palermo, on the 29th.

3. *The British Scientific Expedition.*—A third Report of the proceedings of H. M. S. Challenger has been issued by the Ad-

miralty, giving an outline of the work done, in connection with oceanic geography and its physical condition, between March and November of last year.

Having arrived in safety at Melbourne from her Antarctic cruise, the Challenger left Port Philip on the 1st of April for Sydney, at which place the ship was docked, refitted and completed with coal and provisions. During the stay in that harbor, Prof. Wyville Thomson made a journey to Queensland for the purpose of studying the natural history of tropical Australia.

On the 12th of June the ship left Port Jackson, on her voyage to New Zealand meeting with stormy weather, so stormy indeed as greatly to impede the work of sounding across, and it was unfortunate, as much interest was felt both in New South Wales and New Zealand in regard to the adaptability of the channel bed between them for telegraphic purposes. From the Australian shore the water deepened gradually until a depth was attained of 2600 fathoms, about one-third the distance across; the bottom at this depth consisted of the usual red clay, found in the deepest soundings. A depth of 275 fathoms, with rocky bottom, was found about 280 miles from New Zealand, with slightly deeper water within it. On the 25th, Port Hardy was reached, and Port Nicholson on the 27th. A seaman was unfortunately washed overboard and drowned in Cook Strait. The weather continued wild during the Challenger's stay at Wellington. On the 6th of of July she proceeded on her voyage, passing northward along the east coast of the north island, and on toward the Kermedec group; the stormy weather experienced precluded sounding operations, and the depth between New Zealand and those islands has still to be decided. The results of the dredging near Kermedec proved that animal life was much the same as at the same depths off the coast of Portugal, but several species new to science were obtained.

On the 17th of July, in lat. 25° 5′ S. and long. 172° 56′ E., the deepest cast since quitting the Atlantic was obtained—2,900 fathoms, the bottom temperature being 32°·9, by which temperature it is conclusive that there is a continuous and deep channel extending from the southward into these seas. The Expedition remained two days at Tongatábu, and then left for the Fiji Islands. The ship left the Fiji islands on the 10th of August, and when about thirty miles from the land, a depth was sounded of 1350 fathoms and the red ooze found, which had previously been obtained at only much greater depths. On the 15th, when about midway between Fiji and the New Hebrides group, a cast was had of 1450 fathoms, with the same nature of bottom.

Passing through between the islands of the last-named group, the Challenger proceeded on her way toward Raine Island. A sounding of 2650 fathoms was had, and then four others, slightly shoaling. The serial temperatures of these soundings proved one physical fact, viz: that the sea was cut off by a surrounding ridge, over which the greatest depth of water of any channel through it is 1,300 fathoms, the temperature at that depth being 35°, and then

ntinuing the same to the bottom. Below the 1,300 fathoms in ie hollow between New Hebrides and Torres Strait the water is mparatively stagnant, as in the Mediterranean and other cut-off as.

When 170 miles from Raine Island, the depth was 1,700 fathns, and at seventy-four miles 1400 fathoms, showing that the inination of the bottom of the sea was gradual up to the barrier ef. After anchoring for one night near Raine Island, the Expeition reached Somerset, Cape York, on the 1st of September, here they remained a week, and then proceeded through the anda Sea, carrying a continuous line of soundings, and touching ; Dobbo, Ki Doulan, and Banda. They arrived at Amboina on ie 6th of October, where they obtained coal, and then, passing irough the Molucca passage, reached Ilo Ilo on the 28th, Manila 1 the 4th of November, and Hong Kong on the 19th.

From the temperatures obtained in the Banda, Celebes, Sula, id China Seas, it is evident that their waters are cut off from the eneral oceanic circulation by ridges conecting the islands which irround them.

In each of the seas soundings of over 2,000 fathoms were obined, but in no instance did the temperature decrease regularly om the surface to the bottom, as is usual in the ocean. In every ise, after attaining a certain depth, the temperature below that epth remained the same; thus, in the Banda and China seas, the mperature remained the same from 900 fathoms to the bottom; i the Celebes Sea from 700 fathoms to the bottom; and in the ula Sea from 400 fathoms to the bottom.—*Athenæum*, Aug. 7.

3. *Images produced by Lightning.*—A letter of Professor W. . Brown, of the University of Georgia, to one of the editors, alls attention to a remarkable instance of the formation of imressions upon the human body by a lightning stroke, and encloses tters of Messrs. E. G. Simmons and T. N. Hawkes, of Americus, a., where the occurrence took place, describing the circumstances nd some of the details of the phenomenon.

On the 12th of July, 1875, at about 4 P. M., as Mr. Simmons ates, a stroke of lightning fell upon a house in Americus, renderig insensible for a time four persons who were seated in one of ie rooms. The two outer sides of this room, which was at a orner of the house, had each one window, and nearly opposite iese on the two other sides were the chimney and the door spectively. Outside, a tree stood in front of each of the indows, and about twelve feet from the house. A third tree, a cust, stood opposite the outer corner of the room and about the ime distance from the house as the others. This tree was severed y the lightning, but the other two were not affected. A young iild was sitting near the center of the room, while the mother id a young lady were seated not far from the chimney, near hich, and close to the wall, was another child.

All these persons were rendered insensible for a time by the roke which severed the tree, and on their recovery there were und impressed upon the bodies of them all more or less distinct

images of this tree. It was most distinct in the case of the child near the center of the room. Mr. Simmons says, "the child is impressed upon its back and exactly opposite upon its stomach. The entire tree is plain, and perfect in *toto;* every limb, branch, and leaf, and even the severed part, is plainly perceptible. It is a perfect photograph of the tree, and could not have been made more perfect by a painter's brush. It impressed the young lady upon the left hip and right leg," the mark being quite as perfect as that upon the body of the child. The mother and other child also bore less distinct impressions upon the leg. Mr. Hawkes says, "I saw the youngest child and the marks upon it. The marks on the lower part of the spine are exactly of the shape of a branch of the locust tree. Where the leaves are, on the branch, the mark does not take the shape of the entire leaf, but only of the skeleton of a leaf. The mark was about twelve inches long, and had a fork, exactly like the locust limb. It looked as though the blood was drawn to the skin along the marked part." The marks were not permament, as Prof. Brown, in his letter dated Aug. 7, adds, "a recent letter informs me that the impressions are no longer distinct."

Although many similar cases have been reported, the phenomenon described is rare enough to make a well-marked instance like this worthy of record. The formation of the images in all such cases is readily explained by a peculiarity in the mode of the electric discharge under certain conditions, by imitating which it is possible to produce similar figures artificially with an electrical machine, such as the Holtz machine, capable of giving electricity of very high tension. When the poles of the latter are strongly charged and are separated to the distance of a few inches, the discharge, instead of producing a spark or brush, sometimes consists of a very small jet upon the negative, and a sort of phosphorescent glow upon the positive. The space between them, though not luminous, is the seat of a discharging action which appears to take place along definite lines like a stream or current, and is sometimes called the dark discharge. An object placed between the poles, and in the path of the discharge, interrupts this, and destroys the glow upon the positive pole in points corresponding to the lines thus broken; and in this way there is produced an image or shadow of the interposed object, which is often strikingly distinct and perfect.

In the case above described the phenomena are readily accounted for, if we suppose the thunder-cloud to have been negatively charged, and the tree to have stood in the path of the dark discharge which preceded or accompanied the lightning stroke, the action having been sufficiently intense, and the quantity of electricity great enough, to produce a visible impression upon the delicate tissues of the skin.

A more particular account of the subject may be found in two articles published in this Journal, May, 1870, page 381, and June, 1871, page 437. A. W. W.

5. *Annual Report of the Argentine Meteorological Office*, for he year 1874. 18 pp. 8vo. Buenos Aires, 1875.—This Report, by he Director of the office, Prof. B. A. Gould, gives details as to the rrangements for making meteorological observations which have een introduced into the Argentine Republic, and the present eeds in order that the objects of the meteorological office may e efficiently carried out and rendered of permanent value to sci- nce. Tables of the mean temperature and barometric pressure, f principal points, made out from the observations thus far ob- ained, are given. Mr. Gould states that while at Cordoba the umidity of the air has its maximum in summer, the amount of oisture in February averaging 80 per cent of that requisite for omplete saturation of the atmosphere, and its minimum, 50 per ent in September, at Buenos Aires, on the contrary, the maxi- ium is usually in June, 83 per cent, and the minimum in Decem- er, 60 per cent. During the summer of 1874 the temperature of he solar rays was found at Cordoba to be on December 7th not ess than 74·5° C., and it reached 77·8° on the following January th. The minimum under a clear sky, 52·5° was observed on the 9th of June.

Mr. Gould is making his comprehensive and thorough knowl- dge of terrestrial physics as well as astronomy tell in various ays on the progress of science in South America.

6. *Appletons' American Cyclopædia*, Vol. XI and XII, 1875. -The opening article of volume XI, Magnetism, is by Prof. Jo- eph Henry. It discusses magnetism and diamagnetism, terres- ial magnetism, magneto-electricity, induced currents from dis- harges of ordinary electricity, and induction in masses of metal i motion. Prof. Cleveland Abbe of the U. S. Signal Service con- ibutes the article Meteorology, which is illustrated by numerous iagrams many his own or from original American sources. It is n admirable digest of the present state of this science. Molecule, y Prof. J. P. Cooke of Cambridge, is an article worthy of its ithor, setting forth the latest physico-chemical deductions, and ie author's own views, in a clear and concise manner. The arti- es Metal and Meteorites, Ore dressing, and extraction of metals om their ores by chemical means, are furnished by Dr. Thos. M. rown of Easton and Dr. R. W. Raymond; Mineral deposits, by r. J. S. Newberry; Microscope, by Prof. A. M. Mayer; Mediter- inean Sea, by Count Pourtales; Meteor, Mars, Mercury, Moon, y Richard A. Proctor, London; and the metal Mercury, and ine, by Dr. Raymond.

In volume XII, some of the leading scientific articles are— aleontology, by Prof. James Hall; Mountain, by Dr. T. S. unt; the Theory of Music, by Prof. Mayer; Nebular hypothesis id other astronomical articles, by R. A. Proctor; Chemical omenclature, by Prof. Frank H. Storer of Harvard College. he botanical articles are by Prof. Geo. Thurber; those on Zool- y by Dr. S. Kneeland of Boston; on Materia Medica by Dr. E. . Clark of Harvard University; the medical and physiological r Dr. John C. Dalton; while Drs. Joy and Hogeboom furnish

various chemical articles. From this list of well-known authors and investigators, it is evident that the scientific character of the new edition of Appletons' Cyclopedia is worthy, as a whole, of commendation. We miss occasionally a well-known name among the biographical sketches; for example, Dr. Charles G. Page, whose contributions to dynamical electricity are second only, in this country, to those of Prof. Henry; and the well-known paleontologist F. B. Meek. Other like omissions could easily be mentioned, while some names have a prominence greater than history will award them. B. S.

7. *Boston Society of Natural History.*—The Paleontological collections of the Boston Society of Natural History have been recently much enlarged by the purchase of the collection of Herr Eser of Stuttgart, which is particularly rich in fossils of the Tertiary and Mesozoic formations, including the Triassic. Its specimens of Tertiary plants are of such delicacy that they are mounted, like botanical specimens, on paper. It was secured for the society by the efforts of Mr. A. Hyatt, during his visit in 1874 to Europe, and through the generosity of Mr. John Cummings. In addition several specimens of Ichthyosaurs and Teleosaurs were procured.

8. *Geographical Congress at Paris.*—The recent Geographical Congress at Paris awarded *Letters of Distinction* (highest award) to the Secretary of the Navy for the work of the Coast Survey; and to General Myer, of the Signal Service Bureau; *Medals of the First Class* to Francis A. Walker, for his Physical Atlas of the United States; Dr. F. V. Hayden, for his Rocky Mountain Geological Exploration; and to the Bureau of Statistics, of the Interior Department;—*Medals of the Second Class* to the Committee of Emigration, and the Members of the Tuscarora Expedition.

OBITUARY.

Dr. I. A. Lapham, of Milwaukee, Wisconsin, lately at the head of the Geological Survey of that State, died on the 14th of September. Dr. Lapham was by profession a surveyor, but he was also a good worker in geology, meteorology, and American archæology. Several years since he published a geological map of Wisconsin, and also a map illustrating the influence of the Great Lakes on the climate of Wisconsin. He early drew attention to the Indian mounds of Wisconsin, and a work by him, illustrated by numerous plates, entitled "Antiquities of Wisconsin," was published, in 1855, in the Smithsonian Contributions to Knowledge.

Carl Johann August Theodor Scheerer, the mineralogist, metallurgist, and chemist, died at Freiberg, on the 20th of July last, having been born in Berlin on the 28th of August, 1813. He was the author of various works and memoirs of high merit; among the former his *Lehrbuch der Eisenhüttenkunde* and his well known *Löthrohrbuch* (a treatise on the blowpipe), and among the latter a paper on Paramorphism in its relations to chemistry, mineralogy, and geology.

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[THIRD SERIES.]

ART. XLI.—*On the Variation in the Strength of a Muscle;* by FRANCIS E. NIPHER, Professor of Physics in Washington University, St. Louis, Mo. With plate VIII.

THE strength of a muscle is the maximum weight which it is capable of lifting at a single impulse. It is practically impossible to measure this strength directly, as it necessitates several trials, during which the muscle becomes fatigued. It may, however, be determined indirectly by a method which I shall make the subject of a future paper.

The evidence which we shall now present of variation in muscular strength from day to day, is seen in the variation in the amount of work done by the muscle, before exhaustion. We present here three series of experiments upon the right arms of myself and a former pupil, Mr. D. A. Myers. The first series consisted in finding the maximum pull, which the muscles could exert upon the spring of a dynamometer. The arm was stretched horizontally, grasping the hook of the dynamometer, the palm of the hand being downward, the pull was exerted upward. The arm moves in the vertical plane which makes an angle of 45° with the transverse plane.*

* Prof. Haughton has criticised this position (Nature, vol. xi, p. 488), his point being that some muscles are called into play irregularly. He suggests that the arm should move in the transverse plane, with the palm of the hand upward. This position is a very unnatural one, and the arm will be wholly fatigued in two or three minutes by simply holding the arm in this position when its weight is supported by an external force. Although Prof. Haughton's opinion on this subject is worthy of grave consideration, yet I am not prepared to adopt it in this case. The manner of experiment is determined to some extent by the end to be accomplished, and I am still of the opinion that I have reduced the errors of experiment to a minimum. This point, however, deserves further attention.

In this case, part of the work of the muscles consists in moving the hook of the dynamometer over a certain space, x, under a constantly increasing strain P. The rest of the work done consists in sustaining the strain P, and the fatigue caused is due wholly to molecular motions in the muscle itself. Prof. Haughton has proposed to call the former work "dynamical," the latter "statical" work.

The dynamical work D is then

$$D=\int P.dx, \text{ or as } P=c.x$$

(where c is the tension of the dynamometer spring when $x=$ unity.)

$$D=\int cxdx=\frac{cx^2}{2}+c''$$

or between the limits $x=0$ and $x=\frac{P}{c}$

$$D=\frac{P^2}{2c}. \qquad (1)$$

In like manner the statical work S is

$$S=\int Pdt \quad \text{or as} \quad P=c't$$

where c' is the value of P when t is unity—

$$S=\int c'tdt=\frac{c't^2}{2}+c'''.$$

or between the limits $t=0$ and $t=\frac{P}{c^1}$

$$S=\frac{P^2}{2c'} \qquad (2)$$

The value of D is measured in kilogram-meters; the value of S is measured in kilogram-seconds. It will be admitted that the statical work of holding a weight of w. kilos upon the out-stretched arm, is equivalent to the dynamical work of lifting w. kilos through a certain space. Calling the total work W, we shall have—

$$W=D+k.S. \qquad (3)$$

I propose to call k the dynamical equivalent of statical work. No value has yet been obtained for it which can be deemed more than approximate.

In a series of experiments still in my possession, in which the object was to find the relation of the strength (*s*) to the dynamical work of exhaustion, P was taken provisionally as a measure of the strength. Its variation from day to day is shown graphically on the chart. My experiments are represented by curve F, F; those of Mr. Myers by curve E, E. The strength is laid off on the ordinates. Time is in days laid off on the axis of abscissa. The values of (*s*) determined on the same day are represented by the small circles which lie in the same vertical.

The second series consisted in finding the dynamical work done before exhaustion, in lifting a weight of 5·0 kgr. through a height of 0·7 meters in 1·25 seconds. The manner of experiment has already been described in former papers.* The results of these experiments are shown on the chart. The broken line A B is the series of constant experiments given in the first table, on page 133 of this Journal, for Feb., 1875. The dates of the individual experiments are not known, but no two experiments were separated from each other by an interval of more than two days. Soon after this series was finished, the series represented by the line B C was begun, and these experiments are accurately represented in time. The ordinates represent the number (*n*) of times the weight was lifted before exhaustion, and are laid off on the scale to the left of the chart. D D represents the experiments of Mr. Myers with the same weight, laid off on the scale to the right of the chart.

The third series was made with a view of finding the relation of strength to statical work of exhaustion. The statical work consisted in holding a weight of 5·0 kgr. upon the horizontal arm, the position of the arm being the same as before. The time (*t*) of exhaustion from day to day (in seconds) is shown in the broken lines G, G and K, K the former being my own experiments, the latter those of Mr. Myers.

During the time of these experiments the muscles were kept in gentle training by daily exercises on the swinging rings and parallel bars. This exercise was taken every day, whether experiments were made or not,† and was found very beneficial in reducing the daily variations in strength. On stopping the experiment for a few days the decrease in the power of the muscle is very apparent, and the influence appears most marked upon the observations of the dynamometer. This is due to a difference in training, and it is one of the most difficult points in the whole subject. Two different muscles may have equal strength when measured with the dynamometer, and yet

* This Journal, Feb., 1875, pp. 130–137. Nature, vol. xi, p. 276.

† The time of the summer vacation excepted.

one may be capable of doing twice as much dynamical work as the other with a moderately light weight. This makes it necessary that such experiments should be made on trained muscles.

It will be seen that Mr. Myers is considerably stronger than I, and that variations in the amount of work done are greater for him than for me. This means that variations in strength cause greater variations in the work done by him than in my own case. This is entirely in harmony with the equation given at the close of my paper in this Journal, February, 1875.

During the whole of this series of experiments the size of the muscles did not perceptibly change, while in Myers' experiments the number of lifts with a 5 kgr. weight varied, in two successive experiments (Dec. 20 and 23) from 420 to 1,300.

On the 29th of April, 1873, after a month of exceedingly severe mental work, I was present at a terrible accident, occasioned by the burning of a building. For a quarter of an hour I was under severe mental strain and was for a week completely prostrated. The urinary deposits were enormous, and the condition of the nerves may be inferred from a specimen signature executed, May 6th, after having run violently up a short flight of stairs. Out of about 30 signatures made at that time this was the best. My ordinary penmanship is shown in the signature below, executed on recovery. While in this condition a few experiments were made with the dynamometer, and in lifting the 5·00 kgr. weight, they lie between the dates, April 29 and May 8, inclusive, and are limited by the points marked *a–b* on diagrams F, F and B, C. It will be observed that here, also, the observations with the dynamometer are most affected, while the dynamical work is not perceptibly affected.

Two important results follow from this investigation:

1. After the relation of the strength of a muscle to the dynamical work of exhaustion has been determined, the strength at any time will be most accurately determined, by measuring the dynamical work of exhaustion. On days when from any cause the muscles are temporarily weak, the strength as determined by the dynamometer, and the work of exhaustion with very heavy weights, is less. In exhaustion with lighter weights, however, (5· kgr.) the exercise of the first part of the experiment appears to invigorate the muscle, and the influence of temporary weakness, due to errors in diet, or lack of exercise, or the oppressive atmosphere of the room, is eliminated.

2. The coefficient of muscular power per square centimeter of section of the muscle, is a quantity which varies greatly with different muscles, and with the same muscle at different times; or in other words, the work which a muscle can perform, depends not only upon its size, but also upon its quality.

This helps to explain the different results arrived at in the determination of the coefficient of contraction of different muscles. Thus, the following values in kgrs. per sq. cm. have been found by various experimenters.*

1.	Flexors of arm,	8·99	(Henke.)
2.	" " "	8·19	"
3.	" " "	6·67	(Haughton.)
4.	Extensors of foot,	5·90	(Henke.)
5.	" " "	11·60	(Koster.)
6.	Flexors of leg,	7·78	(Haughton.)

Haughton has pointed out other reasons for such differences, but one of the most important reasons is found in the amount of training which the muscle has received. Hence, muscles which are seldom called into action, have not the same contracting power as those which are daily used.

The experiments here described, as well as those before given in this Journal, were performed while I was an assistant in the laboratory of Prof. Gustavus Hinrichs, to whose kindness I am under many obligations. I also take pleasure in acknowledging experimental aid from Prof. W. C. Preston and Mr. D. A. Myers.

St. Louis, June 15th, 1875.

Art. XLII.—*Studies on Magnetic Distribution*; by Henry A. Rowland, of the Johns Hopkins University, Baltimore.†

Part I.—*Linear Distribution.*

Contents.—I. Preliminary Remarks; II. Mathematical theory; III. Experimental methods for linear distribution; IV. Iron rods magnetized by induction; V. Straight electromagnets and permanent steel magnets; VI. Miscellaneous applications.

I.

In a paper of mine published about two years ago, I alluded to some investigations which I had made in 1870 and 1871 on the distribution of magnetism. It is with diffidence that I approach this subject, being aware of the great mathematical difficulties with which it is surrounded. But as the facts are still in advance of what is known on the subject, and as I see that other investigators‡ are following hard upon my footsteps, I thought it would be well to publish them, particularly as it is no fault of mine that they did not appear some years ago.§

* Haughton's "Animal Mechanics." London, 1873, p. 70.

† Communicated by the author. ‡ Particularly M. Jamin.

§ All the experiments referred to in this paper were made in the winter of 1870–71.

The mathematical theory which I give, although not particularly elegant, will at least be found to present the matter in a new and more simple light, and may be considered simply as a development of Faraday's idea of the analogy between a magnet and a voltaic battery immersed in water. I shall throughout speak of the conduction of, and resistance to, lines of magnetic force, and shall otherwise treat them as similar to lines of conducted electricity or heat, it now being well established from the researches of Professor Maxwell and others that this method gives exactly the same results as the other method of considering the action to take place at a distance.

In arranging this paper I have thought best to give the theory of the distribution first, and then afterward to see how the results agree with experiment; in this way we can find out the defects of the theory, and what changes should be made in it to adapt it to experiment.

At present I am acquainted with two formulæ giving the distribution of magnetism on bar magnets: the first was given by Biot, in his *Traité de Physique Expérimentale et Mathématique*, vol. iii, p. 77, and was obtained by him from the analogy of the magnet to a dry electric pile, or to a crystal of tourmaline electrified by heat. He compared his formula with Coulomb's observations, and showed it to represent the distribution with considerable accuracy. Green, in his "Essay," has obtained a formula which gives the same distribution, but he obtains it by a series of mathematical approximations which it is almost impossible to interpret physically. M. Jamin has recently used a formula of the same form, but I have as yet been unable to find how he obtained it. My own formulæ are also quite similar to these, but have the advantage of being obtained in a more simple manner than Green's, and what is of more consequence, all the limitations are made at once, after which the solution is exact; so that although they are only approximate, yet we know just where they should differ from experiment.

II.

If we take an iron bar and magnetize one end of it either by a magnet or helix, we cause lines of magnetic induction* to enter that end of the bar, and after passing down it to a certain distance to pass out into the air and so around to the bar again to complete their circuit. At every part of their circuit they encounter some resistance, and always tend to pass in that direction where it is the least; throughout their whole course they obey a law similar to Ohm's law, and the number of lines passing in any direction between two points is equal to the dif-

* For difference between lines of magnetic force and lines of magnetic induction See Maxwell's "Treatise on Electricity and Magnetism," arts. 400, 592, and 604.

ference of magnetic potential of those points divided by the resistance to the lines.

The complete solution of the problem before us being impossible, let us limit it by two hypotheses. First, let us assume that the permeability of the bar is a constant quantity; and secondly, that the resistance of the lines of induction is composed of two parts, the first being that of the bar, and the second that of escaping from the bar into the medium, and that the latter is the same at every part of the bar. The first of these assumptions is the one usually made in the mathematical theory of magnetic induction; but, as has been shown by the experiments of Müller, and more recently by those of Dr. Stoletow and myself, this is not true, and we shall see this when we come to compare the formula with experiment. The second assumption is more exact than the first for all portions of the bar except the ends.

Let us first take the case of a rod of iron with a short helix placed on any portion of it, through which a current of electricity is sent. The lines of magnetic induction stream down the bar on either side; at every point of the bar two paths are open to them, either to pass further down the rod, or to pass out into the air. We can then apply the ordinary equations for a derived circuit in electricity to this case.

Let μ be the magnetic permeability of the iron,

R be the resistance of unit of length of the rod,

R′ be the resistance of medium along unit of length of rod,

ρ be the resistance at a given point to passing down the rod,

s be the resistance at the end of the rod,

Q′* be the number of lines of induction passing along the rod at a given point,

Q'_ϵ*† be the number of lines of induction passing from the rod into the medium along a small length of the rod ΔL,

L be the distance from the end of the rod to a given point,

$$r=\sqrt{\frac{R}{R'}},$$

$$A=\frac{\sqrt{RR'}+s}{\sqrt{RR'}-s}.$$

* These are the surface-integrals of magnetic induction (see Maxwell's "Electricity," art. 402); the first across the section of the bar, and the second along a length ΔL of the surface of the bar.

† It is to be noted that $Q'\epsilon$, when ΔL is constant, is nearly proportional to the so-called surface-density of magnetism at the given point.

To find ρ, the ordinary equation for the resistance of a derived circuit gives

$$\rho+d\rho=\frac{(\rho+\mathrm{R}d\mathrm{L})\frac{\mathrm{R}'}{d\mathrm{L}}}{\rho+\mathrm{R}d\mathrm{L}+\frac{\mathrm{R}'}{d\mathrm{L}}}$$

whence $$\frac{d\rho}{d\mathrm{L}}=\frac{1}{\mathrm{R}'}(\mathrm{RR}'-\rho^2),$$

and $$\rho=\sqrt{\mathrm{RR}'}\frac{\mathrm{A}\epsilon^{2r\mathrm{L}}-1}{\mathrm{A}\epsilon^{2r\mathrm{L}}+1} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \quad (1)$$

To find Q′, we have $$d\mathrm{Q}'=\frac{\mathrm{Q}'\rho}{\mathrm{R}'}d\mathrm{L},$$

whence $$^*\mathrm{Q}'=\frac{\mathrm{C}}{\mathrm{A}+1}(\mathrm{A}\epsilon^{r\mathrm{L}}+\epsilon^{-r\mathrm{L}}), \quad . \; . \; . \; . \; . \; . \; . \; . \quad (2)$$

and $$\mathrm{Q}'_\epsilon=\frac{\mathrm{Q}'\rho\Delta\mathrm{L}}{\mathrm{R}'}=r\frac{\mathrm{C}\Delta\mathrm{L}}{\mathrm{A}+1}(\mathrm{A}\epsilon^{r\mathrm{L}}-\epsilon^{-r\mathrm{L}}). \quad . \; . \; . \; . \quad (3)$$

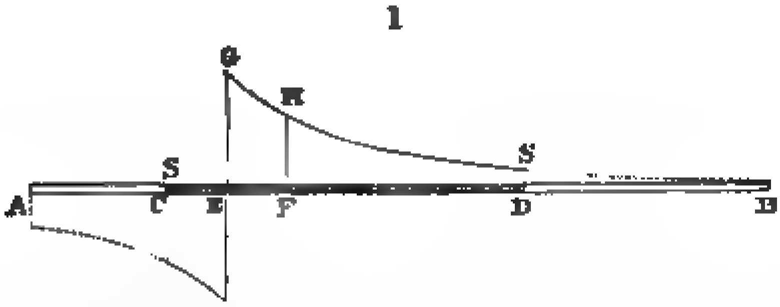
When L is very large, or $\rho=\sqrt{\mathrm{RR}'}$, we have

$$\mathrm{Q}'=\mathrm{C}_,\epsilon^{r\mathrm{L}_,}\text{ and }\mathrm{Q}'_\epsilon=\mathrm{C}_,r\Delta\mathrm{L}\epsilon^{r\mathrm{L}_,},$$

in which $\mathrm{L}_,$ is reckoned from an origin at any point of the rod.

These equations give the distribution on the part ouside the helix, and we have now to consider the part covered by the helix. Let us limit ourselves to the case where the helix is long and thin, so that the field in its interior is nearly uniform.

1



As we pass along the helix, the change of magnetic potential due to the helix is equal to the product of the intensity of the field multiplied by the distance passed over; so that in passing over an elementary distance dy the difference of potential will be $\mathfrak{H}dy$. The number of lines of force which this difference of potential causes in the rod will be equal to $\mathfrak{H}dy$ divided by the sum of the resistances of the rod in both directions from the given point. These lines of force stream down the rod on

* This could have been obtained directly from the equation $\frac{d^2\mathrm{Q}'}{d\mathrm{L}^2}=\mathrm{Q}'r^2$, and Q'_ϵ from the equation $\mathrm{Q}'_\epsilon=\frac{d\mathrm{Q}'}{d\mathrm{L}}\Delta\mathrm{L}$.

either side of the point, creating everywhere a magnetic potential which can be calculated by equation (2), and which is represented by the curves in fig. 1. In that figure AB is the rod, CD the helix, and E the element of length dy. Now if we take all the elements of the rod in the same way and consider the effect at HF, the total magnetic potential at this point will, by hypothesis No. 1, be equal to the sum of the potentials due to all the elements dy.

Let $\Delta Q'$ be the number of lines of force produced in the bar at the point E due to the elementary difference of potential at that point, $\mathfrak{H}dy$,
- $\Delta Q''$ be the number of lines of force arriving at the point F due to the same element,
- Q''_x be the number of lines passing from bar along length ΔL,
- ρ_y be the sum of the resistances of the bar in both directions from E,
- ρ_x be resistance at F in direction of D,
- y be the distance DE,
- x be the distance DF,
- b be the distance CD,
- s'' and s' be the resistance of the bar, &c., respectively at C in the direction of A, and at D in direction of B.
- $\mathfrak{H}$ be the magnetizing-force of helix in its interior,

Let

$$A'=\frac{\sqrt{RR'}+s'}{\sqrt{RR'}-s'};\quad A''=\frac{\sqrt{RR'}+s''}{\sqrt{RR'}-s''};\quad r=\sqrt{\frac{R}{R'}};$$

$$\rho_y=\frac{2(A'A''\varepsilon^{2rb}-1)}{(A''\varepsilon^{2ry}+1)\,(A'\varepsilon^{2r(b-y)}+1)}\sqrt{RR'},$$

$$\Delta Q'=\frac{\mathfrak{H}dy}{\rho_y},$$

$$\Delta Q''=\Delta Q'(A''\varepsilon^{rx}+\varepsilon^{-rx})\frac{\varepsilon^{ry}}{A''\varepsilon^{2ry}+1},$$

$$\Delta Q''=\frac{\mathfrak{H}}{2\sqrt{RR'}}\,\frac{A''\varepsilon^{rx}+\varepsilon^{-rx}}{A'A''\varepsilon^{2rb}-1}(A'\varepsilon^{2r(b-y)}+1)\varepsilon^{ry}dy,$$

$$Q''_x=\frac{\Delta L}{R'}\int\Delta Q''\rho_x=\frac{\mathfrak{H}\Delta L}{2R'}\,\frac{A''\varepsilon^{rx}-\varepsilon^{-rx}}{A'A''\varepsilon^{2rb}-1}\int_x^b(A'\varepsilon^{2rb}\varepsilon^{-ry}+\varepsilon^{ry})dy,$$

$$Q''_x=\frac{\mathfrak{H}\Delta L}{2R'r}\,\frac{A''\varepsilon^{rx}-\varepsilon^{-rx}}{A'A''\varepsilon^{2rb}-1}\,[A'\varepsilon^{2rb}(\varepsilon^{-rx}-\varepsilon^{-rb})+\varepsilon^{rb}-\varepsilon^{rx}]. \quad . \quad . \quad (4)$$

This gives the positive part of Q''_x. To find the negative part, change x into $b-x$, A' into A'' and A'' into A', and then change the sign of the whole.

When the helix is symmetrically placed on the bar, we have $s'=s''$, $A'=A''$; whence, adding the positive and negative parts together, we have

$$Q''_x=\frac{\mathfrak{H}\Delta L}{2\sqrt{RR'}}\,\frac{1-A'}{A'\epsilon^{rb}-1}\left(\epsilon^{r(b-x)}-\epsilon^{rx}\right), \quad . \quad . \quad . \quad . \quad . \quad (5)$$

which gives the number of lines of induction passing out from the rod along the length ΔL when the helix is symmetrically placed on the rod.

To get the number of lines of induction passing along the rod at a given point, we have

$$Q''=\int_0^x Q''_x\,dx=\frac{\mathfrak{H}}{2R}\,\frac{1-A'}{A'\epsilon^{rb}-1}\left(\epsilon^{rb}+1-\epsilon^{rx}-\epsilon^{r(b-x)}\right)+C''', \quad (6)$$

where $$C'''=-\frac{\mathfrak{H}}{r}\,\frac{\epsilon^{rb}-1}{(A'\epsilon^{rb}-1)(\sqrt{RR'}-s')}.$$

When the bar extends a distance L' out of both ends of the helix, so that

$$s'=\sqrt{RR'}\,\frac{\epsilon^{2rL'}+1}{\epsilon^{2rL'}-1}\text{ and }A'=-\epsilon^{2rL'},$$

we have $$C'''=-\frac{\mathfrak{H}}{r}\,\frac{(\epsilon^{rb}-1)(\epsilon^{2rL'}-1)}{(\epsilon^{rb}\epsilon^{2rL'}+1)2\sqrt{RR'}}.$$

It may be well, before proceeding, to define what is meant by magnetic resistance, and the units in which it is measured. If μ is the magnetic permeability of the rod, we can get an idea of the meaning of magnetic resistance in the following manner. Suppose we have a rod infinitely long placed in a magnetic field of intensity $\mathfrak{H}$ parallel to the lines of force. Let Q' be the number of lines of inductive force passing through the rod or the surface-integral of the magnetic induction across its section: also let a be the area of the rod. Then by definition $\mu=\frac{Q'}{a\mathfrak{H}}$. If L is the length of the rod, the difference of potential at the ends will be $L\mathfrak{H}$; hence

$$Q'=\frac{L\mathfrak{H}}{R_{\prime}}\text{ and }R_{\prime}=\frac{L\mathfrak{H}}{Q'}=\frac{L}{a\mu},$$

and R in the formulæ becomes

$$R=\frac{R_{\prime}}{L}=\frac{1}{a\mu}.$$

It is almost impossible to estimate R' theoretically, seeing that it will vary with the circumstances. We can get some idea of its nature, however, by considering that the principal part of it is due to the cylindric envelope of medium imme-

diately surrounding the rod. The resistance of such an envelope per unit of length of rod is

$$\frac{1}{2\pi\mu_{,}} \text{ hyp. log } \frac{D}{d},$$

where D is the diameter of the envelope, d of the rod, and $\mu_{,}$ the permeability of the medium. We are not, however, able to estimate D. If, however, we have two magnetic systems similar in all their parts, it is evident that beyond a certain point similarly situated in each system we may neglect the resistance of the medium, and $\frac{D}{d}$ will be the same for the two systems. Hence R′ is approximately constant for rods of all diameters in the same medium, and r takes the form

$$r = \frac{2}{d}\sqrt{\frac{1}{\pi\mu R'}}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

It is evident that the reasoning would apply to rods of any section as well as circular.

In Green's splendid essay (reprint, p. 111, or Maxwell's 'Treatise on Electricity and Magnetism,' art. 439) we find a formula similar to equation (5), but obtained in an entirely different manner, and applying only to rods not extending beyond the helix. In the 'Reprint' p corresponds to my r, and its value, using my notation, is obtained from the equation

$$\cdot 231863 - 2 \text{ hyp. log } p + 2p = \frac{4}{(\mu - 1)p^2}, \quad . \quad . \quad (8)$$

where $p = \frac{rd}{2}$.

If we make μ a constant in this formula, we must have $p = \frac{rd}{2} = \text{constant}$, hence $r \propto \frac{1}{d}$, which is the same result for this case as from equation (7).

When μ in the two formulæ is made to vary, the results are not exactly the same; but still they give approximately the same results for the cases we shall consider; and since the formula is at the best only approximate, we shall not spend time in discussing the merits of the two.

III.

Among the various methods of measuring linear magnetic distribution, we find few up to the present time that are satisfactory. Coulomb used the method of counting the number of vibrations made by a magnetic needle when near various points of the magnet. Thus in the curve of distribution most often reproduced from his work, he used a magnetized steel bar 27

French inches long and two lines in diameter placed vertically; opposite to it, and at a distance of eight lines, he hung a magnetic needle 3 lines in diameter and 6 lines long, tempered very hard, and the number of oscillations made by it was determined. The square of this number is proportional to the magnetic field at that point, supposing the magnetism of the needle to be unchanged; and this, corrected for the magnetism of the earth, gives the magnetic field due to the magnet alone. This for points near the magnet and distant from the ends is nearly proportional to the so-called magnetic surface-density opposite the point. At the end Coulomb doubled the quantity thus found, seeing that the bar extended only on one side of the needle.

It will be seen that this method is only approximate, and almost incapable of giving results in absolute measure. The effect on the needle depends not only on that part of the bar opposite the needle, but on portions to either side, and gives, as it were, the average value for some distance; in the next place, the correction at the end, by multiplying by two, seems to be inadequate, and gives too small a result compared with other parts. For at points distant from the end the average surface-density at any point will nearly be equal to the average for a short distance on both sides, while at the end it will be greater than the average of a short distance measured back from the end. To these errors must be added those due to the mutual induction of the two magnets.

The next method we come to is that which has been recently used by M. Jamin, and consists in measuring the attraction of a piece of soft iron applied at different points of the magnet. In this case it does not seem to have been considered that the attraction depends not only on the magnetic density at the given point, but also on that around it, and that a piece of soft iron applied to a magnet changes the distribution immediately at all points, but especially at that where the iron is applied. The change is of course less when the magnet is of very hard steel and the piece of soft iron small. Where, however, we wish to get the distribution of soft iron, it becomes a quite serious difficulty. Another source of error arises from the fact that the coefficient of magnetization of soft iron is a function of the magnetization: this source of error is greatest where the contact-piece is long and thin, and is a minimum when it is short and thick and not in contact with the magnet. Hence this method will give the best results when the contact-piece is small and in the shape of a sphere and not in contact with the magnet, and when the method is applied to steel magnets. But after taking all these precautions, the question next arises as to how to obtain the magnetic surface-density from

the experiments. Theory indicates, and M. Jamin has assumed, that the attractive force is nearly proportional to the square of the surface-density. But experiment does not seem to confirm this, except where there is some distance between the two bodies, at least in the case of a sphere and a plane surface, as in Tyndall's experiments (Phil. Mag., April, 1851). It is not necessary at present to consider the cause of this *apparent* discrepancy between theory and experiment; suffice it to say that the explanation of the phenomenon is without doubt to be sought for in the variable character of the magnetizing function of iron. All I wish to show is that the attraction of iron to a magnet, especially when the two are in contact, is a very complicated phenomenon, whose laws in general are unknown, and hence is entirely unsuitable for experiments on magnetic distribution.

A third method is that used in determining the correction for the distribution on the magnets in finding the intensity of the earth's magnetism. Usually the distribution is not explicitly found in this case; but it is easy to see how it might be. Thus one way would be as follows: Take the origin of coördinates at the center of the magnet. Develop the distribution in an ascending series of powers of x with unknown constant coefficients. Calculate the magnetic force due to this distribution for any points along the axis, or else on a line perpendicular to the magnet at its center. Determine the force at a series of points extending through as great a range and as near the magnet as possible. These experiments gave a series of equations from which the coefficients in the expansion can be determined. Other and better methods of expansion might be found except for short magnets, where the method suggested is very good.

The similarity of this method to that used by Gauss in determining the distribution on the earth is apparent.

A fourth method is similar to the above, except that the direction of the lines of force around the magnet are measured and calculated instead of the force.

The last two methods are very exact, but are also very laborious, and therefore only adapted to special investigations. Thus, by the change in direction of the lines of force around the magnet, we have a delicate means of showing the change in distribution, as, for instance, when the current around an electro-magnet varies.

The fifth method is that used lately in some experiments of Mr. Sears (this Journal, July, 1874), but only adapted to temporary magnetization. At a given point on the bar a small coil of wire is placed, and the current induced in it measured by the swing of the galvanometer-needle when the bar is

demagnetized. It does not seem to have been noticed what we ordinarily consider as the magnetic distribution is directly measured in this way; and indeed, to get cor results, the magnetization should have been reversed, se that a *large portion* of the magnetization will not disappea taking away the magnetizing-force where the bar is long. quantity which is directly measured is the surface-integra the temporary magnetic induction *across the section* of the while the magnetic surface-density is proportional to the face-integral of magnetic induction *along a given portion of bar.* In other words, the quantity measured is Q instea $\frac{Q_s}{\Delta L}$. We can, however, derive one from the other very ea

The sixth and last method is that which I used first in 1 and by which most of my experiments have been perform This consists in sliding a small coil of wire, *which just fits bar and is also very narrow*, along the bar inch by inch, noting the induced current over each inch by the deflec of a galvanometer-needle. This measures Q_s, except for s corrections which I now wish to note. In the first case give exact results, the lines of force should pass out perpen ular to the bar, or the coil must be very small. But e when the last condition is fulfilled errors will be introdu at certain portions of the bar. The error is vanishingly sm in most cases, except near the ends, and even there it is large except in special cases; for at this part the lines of f pass forward toward the end of the bar, and so the observat next to the end may be too small, while that at the end is large. The correction can be made by finding where the li of force through the center of the section of the coil in its positions meet the bar. The error from this source is large, and may be avoided to a great extent.

One very great advantage in the method of induced curre is the facility with which the results can be reduced to absol measure by including an earth-inductor in the circuit as I h before described (Phil. Mag., August, 1873.) There is also reaction (except a temporary one) between the magnet and c rent, so that the distribution remains unchanged. Hence seems to me that this method is the only one capable of giv exact results directly.

The coils of wire which I used consisted of from twenty one hundred turns of fine wire wound on thin paper tu which just fitted the bar and extended considerably beyond coils. The width of the coils was mostly from ·1 to ·25 of inch wide and from ·1 to ·2 inch thick. A measure being l by the side of the given bar under experiment, the coil moved from one division of the rule to the next very quic

d the deflection produced on an ordinary astatic galvanome· noted. After experience this could be done with great curacy. It might be better in some cases to have the coil de over a limited distance on the tube, though, for the use I end to put the results to, the other is best.

Up to 35° Q_ϵ is nearly proportional to the deflection; and ıen any larger value is put down on the Tables, it is the sum two or more deflections. I have not the data in most cases reduce my results to absolute measure, but took pains to ıure that certain series of experiments should be comparable ıong themselves.

Having measured Q_ϵ at all points of a rod, we may find Q by ding up the values of Q_ϵ from the end of the rod.

The magnetizing-force to which the bar was subjected was in cases a helix placed at some part of the bar. The iron bars ıre of course demagnetized thoroughly before use by placing em in the proper position with reference to the magnetic melian and striking them.

In the Tables L is the distance in inches from the zero-point, is the deflection of the galvanometer when the helix is ssed between the points indicated in the first column. Thus Table II, 34·7 is the deflection on the galvanometer when e helix was moved from the tenth to the eleventh inch from e zero-point, and so we may consider it as the value of Q_ϵ at ½ inches; so that the values of Q_ϵ refer to the half inches, t Q to the even inches.

In all the calculations the constants in the formulæ were cen to represent Q most nearly, and then the corresponding mulæ for Q_ϵ taken with the same constants.

For ease in calculating by ordinary logarithmic Tables, we ıy put $\epsilon^{rL}=10^{\cdot 4343L}$.

[To be continued.]

RT. XLIII.—*The Effect of the Glacial Epoch upon the Distribution of Insects in North America*; by AUG. R. GROTE, A.M.

(Read before the American Association for the Advancement of Science, at Detroit, Aug. 10th.)

FROM the condition of an hypothesis the Glacial period s been elevated into that of a theory by the explanations it s afforded of a certain class of geological phenomena. The esent paper endeavors to show that certain zoological facts e consistent with the presence, during past time, of a vast ogressive field of ice, which, in its movement from north to ıth, gradually extended over large portions of the North

American continent. These facts, in the present instance, are furnished by a study of our Lepidoptera, or certain kinds of butterflies and moths now inhabiting the United States and adjacent territories. Before proceeding with the subject, a brief statement of the phenomena assumed to have attended the advent of the Glacial period is necessary.

At the close of the Tertiary, the temperature of the earth's surface underwent a gradual change by a continuous loss of heat. The winters became longer, the summers shorter. The tops of granitic mountains in the east and west of the North American continent, now in summer time bare of snow and harboring a scanty flora and fauna, became, summer and winter, covered with congealed deposits. In time the mountain snows consolidated into glacial ice, which flowed down the ravines into the valleys. Meanwhile the northern regions of the continent, which may have inaugurated the conditions, submitted extendedly to the same phenomena. Glacial ice, first made on elevations, finally formed at, and poured over, lower levels. Glacial streams finally united to form an icy sea, whose frozen waters slowly plowed the surface of the rocks, and, in their movement from north to south, absorbed the local glacial streams in their course, and extended over all physical barriers. The Appalachians and Rocky Mountains are supposed to have had local glaciers. The animals must always have retreated before this frozen deluge. The existing insects of the Pliocene, in submitting to the change of climate which accompanied the advance of the glacier, must have quitted their haunts with reluctance, and undergone a severe struggle for existence, no matter how gradually they had been prepared for the encounter. We may expect that multitudes of specific formsultimately perished, of whose remains no traces have been perserved.

After this brief statement of the outlines of the opening of the Glacial period, we turn to some facts offered by a study of certain of our existing species of butterflies and moths.

The tops of the White Mountains and the ranges of mountain elevations in Colorado offer us particular kinds of insects, living in an isolated manner at the present day, and confined to their respective localities. In order to find insects like them we have to explore the plains of Labrador and the northern portion of the North American continent, in regions offering analogous conditions of climate to those existing on the summits of these mountains. The genera *Oeneis* and *Brenthis* among the Butterflies, and *Anarta* and *Agrotis* among the Moths, are represented by the same or similar species in all of the above mentioned localities. In the case of the White Mountain butterfly, *Oeneis semidea*, we have a form sustaining itself on a very lim-

ted Alpine area on the top of Mount Washington.* Although here is some doubt whether precisely the same form of *Oeneis* ias been discovered in Colorado, the fact remains that *Oeneis*, utterflies exceedingly like it, though registered by us under different specific names, live in Labrador and Colorado. Whether he White Mountain butterfly, *Oeneis semidea*, be, as suspected y Lederer, a modification of some of the Labradorian forms of he genus, or not, the geographical distribution which its genus njoys cannot be meaningless. The question comes up, with egard to the White Mountain butterfly, as to the manner in rhich this species of *Oeneis* attained its present restricted georaphical area—How did the White Mountain butterfly get up he White Mountains? And it is this question that I am disosed to answer by the action attendant on the decline of the ilacial period.

I have before briefly outlined the phenomena attendant on he advance of the ice-sheet, and I now dwell for a moment on he action which must equally be presumed to have accompaied its retirement. Many of the features of its advance were epeated, in reverse order, on the subsidence of the main iceheet or glacial sea. The local glaciers appeared again, separate rom the main body of ice, and filled the valleys and mountain avines, thus running at variance with the main body of the ;lacier, being determined by local topography A reversal of he temperature shortened the winters and lengthened the sumners. Ice-loving insects, such as our White Mountain butterly, hung on the outskirts of the main ice-sheet, where they ound their fitting conditions of temperature and food. The nain ice-sheet had pushed them insensibly before it, and during he continuance of the Glacial period, the geographical distribuion of the genus *Oeneis* had been changed from a high northern egion to one which may well have included portions of the outhern States. And, on its decline, the ice-sheet drew them ack again after itself by easy stages; yet not all of them. ome of these butterflies strayed by the way, detained by the hysical nature of the country and destined to plant colonies part from their companions. When the main ice-sheet left the oot of the White Mountains, on its long march back to the ole, where it now seems to rest, some of these wayward, fliting *Oeneis* butterflies were left behind. These had strayed p behind the local glaciers on Mount Washington and so ecame separate from the main body of their companions,

* See Mr. Scudder's article in the "Geology of New Hampshire," i. 342. Mr. cudder first pointed out the existence of Alpine and sub-Alpine faunal belts on Iount Washington, and makes the interesting remark. "that if the summit of Iount Washington were somewhat less than two thousand feet higher, it would each the limit of perpetual snow."

which latter journeyed northward, following the course of the retirement of the main ice-sheet. They had found in elevation their congenial climate, and they have followed this gradually to the top of the mountain, which they have now attained and from which they cannot now retreat. Far off in Labrador the descendants of their ancestral companions fly over wide stretches of country, while they appear to be in prison on the top of a mountain. I conceive that in this way the mountains may generally have secured their alpine animals. The Glacial period cannot strictly be said to have expired. It exists even now for high levels above the sea, while the Esquimaux finds it yet enduring in the far north. Had other conditions been favorable, we might now find Arctic man living on snow-capped mountains within the Temperate zone.

At a height of from 5,600 to 6,200 feet above the level of the sea, and a mean temperature of about 48 degrees during a short summer, the White Mountain butterflies (*Oeneis semidea*) yet enjoy a climate like that of Labrador within the limits of New Hampshire. And in the case of moths an analogous state of things exists. The species *Anarta melanopa* is found on Mount Washington, the Rocky Mountains and Labrador. *Agrotis Islandica* is found in Iceland, Labrador, the White Mountains, and, perhaps in Colorado. As on islands in the air, these insects have been left by the retiring ice-flood during the opening of the Quarternary.

On inferior elevations, as on Mount Katahdin, in Maine, where we now find no *Oeneis* butterflies, these may formerly have existed, succumbing to a climate gradually increasing in warmth from which they had no escape; while the original colonization in the several instances, must have always greatly depended upon local topography.

I have briefly endeavored to show, that the present distribution of certain insects may have been brought about by the phenomena attendant on the Glacial period. The discussion of matters connected with this theoretical period of the earth's history thus brings out more and more clearly, as it now appears, the fact of its actuality. I hope that my present statements may draw the attention of our zoologists more to the matter, seeing that we have in our own country fields for its full exploration.

ART. XLIV.—*Æstivation and its Terminology*; by ASA GRAY.

THE term *æstivation*, to denote the arrangement of the parts the calyx, corolla, &c., in the bud, as well as that of *vernation* r leaves in a leaf-bud, was introduced by Linnæus. He did t elaborate the former subject as he did the latter, and the w terms given to the modes he recognized are for the most rt defined merely by a reference to their use in vernation. 'stivation as a botanical character is comparatively recent, d its terminology is not yet quite satisfactorily settled. I opose to consider, 1, what the leading modes are, and 2, w they are to be designated.

1. In the first place, the modes of æstivation may be con-niently divided into two classes, those in which the parts erlap, and those in which they do not.

Of overlapping æstivation, only two principal kinds need primarily distinguished, viz: 1. where some pieces overlap d others are overlapped, i. e., some have both margins exterior d others both margins interior or covered; 2. where each ece of a circle is overlapped by its neighbor on one side while overlaps its neighbor on the other. There are mixtures and bordinate modifications of these two, but no third mode.

In æstivation without overlapping, there is first, the rare case which the parts of the whorl or cycle never come into con-t in the bud; and secondly, that in which they impinge by eir edges only. There is also the case in which both margins each piece are rolled or bent inward, and the rarer one in ich they are turned outward; and the apex of each piece may mport itself in any of these ways. But these dispositions are ose of the pieces or leaves taken separately, and the terms plied to them are the same as in vernation or prefoliation, e used in the same sense, and so are not at all peculiar to stivation or prefloration. The like may be said of a remain-g mode, which belongs, however, to a different category, that which the parts being united into a tube or cup, this is dily plaited into folds, or otherwise disposed. In which case e margin of the tube or cup, or such lobes as it may have, ay exhibit any of the modes of æstivation above indicated.

Without further notice, then, of this last, the *plicate* or *aited* æstivation, and of analogous conformations of the tube cup of a calyx or corolla, or of the disposition of each piece dividually (whether *revolute*, *involute*, *reflexed*, *inflexed*, and the ce)—about the terminology of which there is no question,— nitting, likewise, for the latter reason, the case of *open* æstiva-on, there are left three types to deal with:

I. With some pieces of the set wholly exterior in the bud to others.

II. With each piece covered at one margin, and covering by the other.

III. With each piece squarely abutting against its neighbors on either side, without overlapping.

In modes II and III, the pieces are all on the same level and are to be viewed as members of a whorl. In mode I, although they may sometimes be members of a whorl, some parts of which have become external to others in the course of growth, they may, and in many cases must belong either to two or more successive whorls (as in the corolla of *Papaveraceæ*, and even the calyx of *Cruciferæ*, the upper or inner of course covered by the lower or outer), or to the spiral phyllotaxy of alternate leaves.

The type of the latter, and the common disposition when the parts are five, is with two pieces exterior, the third exterior by one edge and interior by the other, and two wholly interior. This is simply a cycle in $\frac{2}{5}$ phyllotaxy, the third piece being necessarily within and covered at one margin by the first, while it is exterior to and with its other margin covers the fifth, this and the fourth being of course wholly interior. So, likewise, when the parts are three, one exterior, one half exterior, and one interior or overlapped, the æstivation accords with $\frac{1}{3}$ phyllotaxy. When of eight or higher numbers the spiral order is usually all the more manifest. When of four or six, the case is one of whorls (opposite leaves representing the simplest whorl), either of a pair of whorls (as in *Epimedium*, *Berberis*, &c.), or a single whorl, the parts of which have overlapped in cyclic order.

2. As to the terminology. Linnæus in the Philosophia Botanica treats only of Vernation, there termed *Foliatio*. For this the former term was substituted, and that of *æstivation* [redacted]

;ood ; but the diagram, tab. x, 6, shows that case I is
'd. *Convoluta* refers to the rolling of a petal or leaf by
s does *conduplicata* to its folding; but Linnæus gives
ures, one of a single rolled-up leaf, the other of one leaf
ıp within another.

lly, among the modes of vernation indicated by Lin-
there is one which it is important here to notice,
; as it does to the arrangement of a pair of leaves in
d, and evidently quite as applicable to a whorl of a
ıumber of parts than two, i. e.—

'oluta, quum margines alterni comprehendunt oppositi
arginem rectum." Phil. Bot., 105. Or, in Term. Bot.,
a superiore lateribus approximatis ita ut alterum latus
uat alterum folium."

, as the definition and the diagram in the Philosophia
:a show, answers in æstivation to mode II. It was
ıken up as such by Mirbel (Elem. Phys. Veg. et Bot.,
, 738, 739), where the polypetalous corolla of *Hermannia*
ralis, and the gamopetalous corolla of *Apocyneæ* are
; examples.

ate æstivation, our mode III, is rightly defined by
in the same place, and still earlier by Brown.

æus made no use of æstivation as a character. Nor
ısieu, except merely that, in his Genera Plantarum, the
)f *Malvaviscus* are said to be *convolute*.

)eCandolle's Théorié Élémentaire, 1813—a still unsur-
treatise, upon which, next to the Philosophia Botanica,
tanical glossology rests—neither the word æstivation,
synonym, prefloration, is mentioned, and even verna-
prefoliation is equally omitted.

the history of æstivation as a botanical character began
'ork published three years earlier, viz., in R. Brown's
mus Floræ Nov. Holl., 1810. The Preface notes that
first accurately observed by Grew. In it Brown *defines*
he *valvate* mode, "ubi margines foliolorum vel lacini-
ntegumenti invicem applicati sunt, capsulæ valvularum
lum." In the body of the work, wherever it is impor-
ıe æstivation is noted as *valvate*, *imbricate*, *plicate*, *indu-*
&c. ; and the open æstivation (*aperta*) is named by him
bsequent paper.

g the first to employ æstivation systematically, and to
ɔ its value, Brown's terminology for its modes may well
ɪidered authoritative. And so indeed it is, as far as it
But he did not make one important distinction viz., that
n our I and II. Imbricate, in his use, comprises all
)f overlapping, that of the corolla of *Apocyneæ* and of a
n, as well as that of a Primrose. He must have not
oticed the difference, but also appreciated its general

importance, notwithstanding the occasional passage of the one into the other He must have also observed that in many cases, as in *Asclepias* for instance, the mode II passes into mode III, the valvate, and may possibly have discerned that under a phyllotaxic view these are more nearly related than either is to mode I. I find, however, only one instance in which he has indicated the distinction, viz., in the character of *Burchellia*, furnished to the Botanical Register, t. 435. 1820. Of its corolla it is said: "æstivatione mutuo imbricata contorta." The phrase is interesting, as it seems to recognize the distinction between the mode of overlapping (which is that of our mode II) and the torsion, which only now and then accompanies it. Looking over the Plantæ Javanicæ Rariores to see if there is any later use, I find no instance in which Brown has occasion to speak of this mode II; but it occurs in the portion of his associate, Mr. Bennett, who (on p. 212) describes the petals of *Sonerila* as "æstivatione *convoluta*." Had this term been thus employed by Brown himself, and at an earlier date, I should regard the terminology of these three modes of æstivation as settled, viz.: I. *imbricata*, II. *convoluta*, III. *valvata*. The first and the third are established beyond question, although somewhat remains to be said about the first.

But meanwhile another use has prevailed as respects the second. In DeCandolle's Prodromus, the first general or considerable work after Brown in which terms of æstivation are employed, this mode is almost uniformly characterized as *contorta*. I cannot at this moment trace the term to its origin. It was probably suggested by the name *Contortæ*, said to have been given by Linnæus to the Apocyneous natural order; and it seemed appropriate to the instances in which the strong convolution of rounded petals, as in *Oxalis*, or their lobes, as in *Phlox*, give an appearance like that of twisting, although there is no twist or torsion But it is to just such cases, in which there is most of seeming twisting on account of the strong convolution, that the term *convolute* is now and then assigned in the Prodromus; as in the character of *Byttneriaceæ*, and that of *Malvaviscus*. The latter may perhaps be explained by the peculiarity that the petals do not uncoil in anthesis But in *Apocynaceæ*, in the Prodromus, the terms *convoluta* and *contorta* are seemingly employed synonymously, or nearly so (the latter most frequently); at least I see no difference between the æstivation of *Allamanda*, said to be contorted, and that of *Vinca* (*rosea*), said to be convolute. Endlicher in this regard follows the Prodromus. In the new Genera Plantarum by Bentham and Hooker this mode is most commonly designated as *contorta*, sometimes as *contorto-imbricata*, rarely (*Philadelphus*, &c.) *convoluta*. I have myself, from a period as early as 1840, employed the term convolute, thinking it unadvisable to have two names

for the same thing, and wishing to restrict, if it might be, the term contorted to cases of torsion. Adrien de Jussieu, on the other hand, used convolute (with strict Linnæan propriety) for regular imbrication with a high degree of overlapping, thus giving two names to different degrees of the same thing.

It being conceded, I presume, that the mode II should be specifically distinguished, what name, on the whole, ought it to bear? If we follow prevalent usage, *contorta* will be the term. But this term was unknown in this sense to the founders of æstivation, Linnæus and Brown: it correctly expresses the real state of things in only a few cases; and where there is torsion, it leads to a most awkward way of expressing it. We have to write: "lobes of the corolla contorted and twisted: *corollæ lobi contorti et torti*," introducing *dextrorsum* or *sinistrorsum*,* to express the direction of the overlapping and of the torsion, which are not always the same. So that the most current name is the least appropriate. *Convoluta* is as good a name as can be, and its use in the present sense is not unconformable with the Linnæan use in vernation. When well carried out, three or five or more petals, as the case may be, are simply rolled up together. When the overlapping is slight, there is simply the tendency to convolution. But if, as in other nomenclature, priority gives a paramount claim, *obvoluta* will be the proper term, beginning as it did with Linnæus for vernation, and taken up, as it was very early, by Mirbel for æstivation. The only objections to it are, first, that it has never come into systematic use, and second, that *ob* in the composition of botanical terms, commonly stands for obversely or inversely. But *obvoluta* is not burdened with this signification: it is classical for "wrapped round," as is *convoluta* for rolled together. I conclude that one or the other of these two terms ought to be used.

Finally, although there is little, if any, practical misuse, there is some mis-definition, of the term *imbricate* as applied to æstivation. Adrien de Jussieu defines it well (in Cours Élémentaire, 308) in the phrase "La préfloraison spirale est aussi nommé *imbriquée;*" and in noting that when the number stops at five, the pieces fall into two exterior, two interior, and one (the third in the spiral) intermediate, this making what is called *æstivatio quincuncialis*.† This is clear and to the point. But other authors have had a fancy for distinguishing between

* I note with satisfaction that Bentham and Hooker use these terms to signify from left to right, or from right to left, of a person, supposed to stand outside of the closed bud, which is surely the natural position of the observer.

† The name *quincuncial* answers the purpose after definition, and has long been in use; but this arrangement in diagram is wholly unlike the *quincunx*, with its four pieces or stars in the periphery, or at the angles of a square, and one in the center.

quincuncial and imbricate (as if the former were not the typical case of the latter when the parts are five), and so have had to devise something else to answer to imbricate. Alphonse De Candolle (in his Introd. Bot., i, 154, written before phyllotaxy was well understood), after relegating *imbricative* to the category of a crowd of verticils, and remarking that the quincuncial is sometimes confounded with the imbricate, adds: some confound also under this latter name the case in which there is one exterior piece, one interior, and three covered at one margin but free at the other. I know not where this began; but its latest reproduction is in Le Maout and Decaisne's Traité Général, and in the English translation of it. In the diagram the pieces are numbered directly round the circle from 1 to 5, the fifth coming next the first: "so they thus complete one turn of a spiral,"—which shows that Le Maout had vague ideas of phyllotaxy, of which he seems to have invented a new ($\frac{1}{5}$) order. Moreover this is essentially identical with the *cochlear* æstivation of the same work (not of Lindley); and Eichler, in his Blüthendiagramme, adopts this name (unsuitable though it be), for this particular arrangement, whatever be the position of the enclosed or enclosing petal. A glance shows that this supposed "true imbricate æstivation" is a slight and not very uncommon deviation (by the displacement of what should be the interior margin of one of the petals during growth) of the mode II, variously termed obvolute, convolute, or contorted æstivation. But it is so intermediate between this and the quincuncially imbricate as perhaps to justify Brown in applying the name imbricate generically to all the overlapping modes. I see, since the above was written, that Eichler, in his Bluthendiagramme, in effect does this. I find also, that Eichler uniformly employs the term *convolute*, or *convolutive*, as I have done, instead of contorted. I should hope, rather than immediately expect, that this use would become general.

ART. XLV.—*Abstract of a Memoir on the "Biological Relations of the Jurassic Ammonites;"* by Professor A. HYATT.*

THE speaker traced the history of the evolution of the order of Ammonoids, showing that the characteristics of the first three stages of the embryo were inherited from a very early period. These were first, the sac-like shell of the embryo containing the equally sac-like beginning of the siphon,—prosiphon as it has since been called by M. Munier-Chalmas; second, the begin-

* From the Proceedings of the Boston Society of Natural History, vol. xvii, December 16, 1874.

ing of the true shell or apex, with its nautilus-like septum, and peculiar nautilus-like umbilicus; third, the depressed and goniatite-like continuation of the form fo the shell with its accompanying goniatitic septa.

These of course represent only their most advanced stage in the Ammonites proper of the Jura and Trias; they are, when first observed in the Silurian and Devonian, exceedingly variable in the length of the periods and other important characteristics even between the varieties of different species. They become invariable in the young as embryonic characteristics only after the lapse of time represented by the Silurian, Devonian, and Carboniferous periods. This variability in the same species in the Silurian shows how recently they were inherited, and their invariability in every individual of the Jurassic show the result of the long ages of inheritance through which the group has passed between that period and the Silurian epoch.

He then showed that in each subordinate group there were certain invariably occurring forms precisely similar to those found in other groups often widely removed in time and very distinct in the structure of the parts. These are apt to occur with a certain fixity of succession which enables the observer to predict with considerable certainty the general characteristics of the succeeding forms of any given group after he has thoroughly studied the development and succession of a few of the lowest. They correspond to what naturalists are in the habit of calling paralled forms, often also representative forms. These forms begin in every group with which I am acquainted with a certain low or open-whorled form and evolve, in course of time and by inheritance, more and more involved whorls, or else the whorls are modified in the characteristics which usually accompany the normal increase of the involution, namely, by the increasing thinness of the shell laterally, flatening of the sides which becomes more and more convergent outwardly, and the tendency of the abdomen to become narrower. This and the origin of most of the groups from certain single ancestral species of the discoidal or open-whorl forms show conclusively that these forms rise independently in each group.

But it must be noticed that they can be only thus limited in each group or series of groups which are genetically connected. The range of forms comprehends every imaginable modification of the original inherited or stock form of the third stage among Ammonites. This is tubular or coniform and has an inherited tendency to grow by increasing the abdominal more than the dorsal side, thus revolving upon itself. Therefore while the choice or selection of the original forms by which a series starts

into being is practically unlimited except by the possibilities of the typical discoidal form of the embryo and young, the subsequent development in each series becomes more and more limited according to the size of the group. The same law of inheritance which renders the embryonic form of the third stage fixed or invariable in each individual of the true Ammonites of the Jura, subsequently accomplishes the same purpose, to a less degree and with greater fluctuation, for the later developed forms and characteristics of each separate series or group, obliging them to evolve, if they progress at all, a certain succession of forms which have been described above.

It will be noticed that I use the word progress in a special sense as applicable to a certain class of paralled forms and not to those with which we shall presently deal, the old-age forms, which though equally perfect in the phenomena of parallelism, cannot be attributable to growth. The former are the mechanical results of the growth or increase in size of the shell of the common embryonic form of the third and succeeding stages of the young, while the latter result from the natural but inevitable loss of growth-force in the adult shell and its parts.

This growth seems to me to be due to the favorable nature of the physical surroundings, primarily producing characteristic changes which become perpetuated and increased by inheritance within the group. We can recognize this in the constantly increasing size of the shell, complication and development of the new parts, as has been shown by Prof. Cope in his "Method of Creation of Organic Types." Though he does not attribute so much to the influence of the physical surroundings as has been done here, the result of my investigations are, as they have been heretofore, very similar to his.

The law or general expression for the mode of inheritance by which this is accomplished is the same for all characteristics, whether of form or structure: namely, that of acceleration. By this I mean the constant tendency of every individual to inherit the characteristics of its parents at earlier periods than those in which they have appeared in the parents themselves. I know of no exception to this law, whether the characteristics are due to a healthy adult condition or to old age; whether they precede or succeed the supposed period of reproduction. This I have already treated of fully in previous publications, and need only refer to the old parallel forms, presently to be treated of, in order to make it clear to every zoologist that senile characteristics must be inherited or these series of senile parallel forms could have no existence.

This constant tendency to reproduce the ancestral characteristics at earlier and earlier stages accounts for the reduction of the principal characteristics of the Nautiloids and Goniatites to

an embryonic condition in the young of the Jurassic Ammonites.

It also accounts for the inheritance of the more and more involved form in each of the subordinate series. This becomes apparent when the parallel forms of any series are traced from the primary discoidal or open umbilicated through the intermediate forms to the most completely involved.

We find in all cases the more discoidal or primary with all its characteristics, whatever they may be, repeated at earlier stages in each species, until at last in some of the most involved, all perceptible traces of its existence are lost. Then and only then can the series be said to die a natural death. When this form appears I have never found another. The reason for this is that in all cases the disappearance of the primary or ancestral form and characteristics of the series is due to the encroachments of the inherited old age characteristics. When these, which are essentially degradational, begin to be inherited in a race, the adult characteristics begin to be confined to younger periods of growth and finally disappear altogether; the shell showing certain old age or inherited senile characteristics from the beginning of the fourth stage. Everywhere this mode of inheritance by acceleration occurs, everywhere it seems to govern the succession of the forms. I have not, however, been able yet to trace the precise connection between all the roots of the secondary series. If this could be completely done, which I fear is impossible at present, no doubt some similar relations would be found.

Besides those parallel forms which may be called progressive, there are others in the same groups which may be shown to be due to the inheritance of the old age of these same parallel forms, and, by comparison with similar forms prematurely produced in different species by disease or local influences, they may be attributed to similar causes, namely, the action of unfavorable surroundings. It is no exaggeration to say that in many instances the small, dwarfed forms produced by disease are very similar to the normal and large old age forms of the same series. This resemblance extends sometimes even to the mode of development. Disease thus produces directly an effect similar to the normal action of the laws of inheritance through a greater or less period of time under the influence of physical surroundings.

The word surroundings is now used instead of environment, for the reason that environment covers the whole ground of physical causes which may have either a remote or immediate effect upon the life of the species.

The environment, or the sum of the physical influences, however favorable it may seem to be, is, as is well known to all

physiologists, perpetually inimical to the prolonged existence of life, and brings about in the individual the retrograde metamorphoses known as old age, and leads to death by disuse, atrophy and decay of the functions and organs.

These changes in the individual are in precise correspondence with those taking place in a group, and, as has been shown, these characteristics are acted upon in their transmission from individual to individual, during the decline of the group, by the same law of inheritance as are the progressive characteristics during its rise. Thus it becomes possible to compare the life of the individual with the life of the group to which it belongs, the period of growth and development to the period of the progressive evolution of new forms, and the period of old age with its retrograde metamorphoses to the period of decline during which retrogressive forms are evolved. This comparison and the facts noted above enable us to attribute the parallel modifications of forms, whether occurring during the progressive or declining period in the existence of a group, to the direct influence of environment.

Besides these characteristic forms and structural parts which are parallel, there are many others in each group not classified under the head of similiarities but under that of differences, in so far as they distinguish the groups from each other. These may be often followed back to varieties of one species, showing that certain varieties have given rise to the groups. These varieties are few as compared with the whole number of varieties traceable in these original ancestral species.

Thus it seems clear, that these varieties must have had certain advantageous peculiarities enabling them to survive the climatic or geological changes, which destroyed the weaker descendants of the same stock, and that these peculiarities rendered them capable of perpetuating their race until they arose into a group or series of genetically connected forms.

Unless the Darwinian law of natural selection, or the survival of the fittest, does apply to the perpetuation of these structural differences which distinguish groups from each other, I am entirely at loss in my attempts to account for them. I here carefully guard against attributing the origin of these differences to the law of natural selection, but limit its action strictly to the modification of the structural differences which tend to appear first in the varieties and then by inheritance in larger and larger groups and at earlier and earlier stages in the life of the individual.

It may also be shown by Cope's law of the origination of differences by growth that the origin of these differences probably lies in some law of growth under the influence of physical surroundings, supply and kind of food, climate, etc. Thus they

may be said to be due to growth modified and directed by the Darwinian law of natural selection, both of these being directly subject to the influence of environment, or the sum of all the physical influences brought to bear upon the organization.

This conclusion, it will be noticed, is strictly in accordance with the general tendency of zoological opinions at the present time and almost identical with the results taught by Herbert Spencer in his works on biology, although I was not aware of this until after they were written. Many of the facts supporting the position assumed have already been published in various scattered papers, but those will be united and accompanied by others since discovered in the partially completed memoir of which this is the abstract.

ART. XLVI.—*A Note in relation to the mass of Meteoric Iron that fell in Dickson County, Tenn., in* 1835; by J. LAWRENCE SMITH, Louisville, Ky.

EVERY metallic particle in the interior of a meteoric stone is a complete miniature type of the large masses of meteoric iron which have been discovered in different parts of the world, but not seen to have fallen, leading to the natural conclusion that they must have fallen at periods anterior to the date of their discovery. And it is an interesting fact in celestial meteorology, that the stony meteorites, with their little particles of metal, fall with comparative frequency. Yet the fall of iron masses free from earthy matter is so rare that we have but four authenticated cases: that of Agram in Croatia, in May, 1751, that of Braunau, Bohemia, in July, 1847, that of Victoria, Africa, in 1862, and the one which now forms the subject of this communication, which fell on the 1st of August, 1835, near Charlotte, Dickson County, Tenn., U. S.; lat. 36° 15′, long. 87° 22′. A short description was given by Professor Troost of Nashville, and published in this Journal in 1845. Prof. Troost dying very shortly after that period, his cabinet of minerals and other objects of natural history were placed in boxes by his executors, and have remained thus until within the past few months, when they passed under my control. The scientific world knowing so little of this meteoric iron, I at once proceeded to its examination; and, as only a small part of one end, weighing two or three hundred grams, had been cut off, it was easy to restore that from a drawing, and obtain a perfect cast of the mass, which has been done. My reason for making the present communication is to call attention to the remarkable features of this most interesting meteorite,

which, although it is forty years since it fell, has not been seen by a half dozen scientific men.

This meteorite fell during the day-time, in a field where several persons were at work, frightening a horse attached to a plough, who ran wildly about the field dragging the plough after him. It struck the ground at the root of a large oak, descending at rather an acute angle, and burying itself in the roots of the tree. The sky was cloudless and a noise was heard preceded by a vivid light. Other particulars connected with its fall, as well as a description of its size and form, have been already published by Prof. Troost. It is of an elongated kidney shape and remarkably symmetrical form, the metal being bright and almost polished on many parts of the surface, and it has remained in this condition ever since it was discovered, although exposed to such atmospheric conditions as usually rust and tarnish iron; it is in this respect unique among meteoric irons, as well as in another particular first noted by Prof. Troost. Although to the naked eye the surface has the appearance of smooth cast iron, the smoothness of the surface in many parts disappears when examined through a lens; "it is then seen to have a reticulated surface, formed by the edges of thin laminæ of metal, separated from each other by an apparently semi-fused or slaggy matter. These laminæ running in an inclined position into the mass, intersect one another at angles of 60°, and forming equilateral triangles, would divide the mass into regular octahedrons. The accompanying cut will better exhibit these lines very much magnified.

Another noteworthy fact in connection with this iron (which is soft and tough) is that when cut and polished, it will resist the tarnishing effects of the ordinary vapors of the laboratory, as I have pieces which have been thus exposed for several months.

By the agency of heat or acid the Widmannstättian figures are developed with exquisite beauty, not equalled except by three or four known meteoric irons. In connection with these figures I will call attention to the delicate parallel lines inside of these figures, which I pointed out several years ago as being peculiar to certain of the irons, they being not contained in all Widmannstattian figures, and which I designate by the term „Laphamite markings."

This iron is not absolutely compact, for one can trace, even with the eye, minute cavities which are distinctly visible with a lens; but I have not yet been able to detect any schreibersite either on the surface or in the interior of the mass.

Its specific gravity is 7·717.

On analysis it was found to consist of

Iron	91·15
Nickel	8·01
Cobalt	·72
Copper	·06

No trace of sulphur was detected, and so minute a trace of phosphorus, that only a few exceedingly small crystals of phosphate of magnesia and ammonia could be discovered in the test made with a gram of the iron, representing only a small fraction of a milligram of phosphorus. In fact, I have never yet analyzed a meteoric iron containing so little phosphorus. In regard to the gaseous contents of this iron, the following were the results obtained by Prof. W. Wright, who made an examination of them at my request.

"The iron being exposed to a red heat gave a little more than twice its volume of gas. It can be estimated as 2·2, without an appreciable error. It did not appear to be given off readily, and doubtless a larger portion would have been obtained if the iron had been in a more thoroughly divided state. An analysis of the gas gave

H	71·04
CO	15·03
CO_2	13·03

There did not appear to be any appreciable quantity of nitrogen."

It is a question of no small interest, in connection with the fall of meteoric irons, whether or not they are heated to a sufficient degree of intensity to fuse the surface of the metal. The present meteorite would appear to solve this question in the negative; for if the surface had been melted the delicate reticulated structure, which is discoverable by the glass, would have disappeared, and it would have had an irregular melted exterior. In the present case this oxide exists on the edges and between the striæ; which serves to show that the surface of the iron, although not melted, was nevertheless intensely heated, and had been preserved from fusion only by the rapid conduction of the heat from the circumference to the center. And this should be the case with nearly all, if not all, the masses of iron which have fallen.

The Braunau iron was not near the point of fusion; otherwise it would have set fire to the rafters of the house in which a

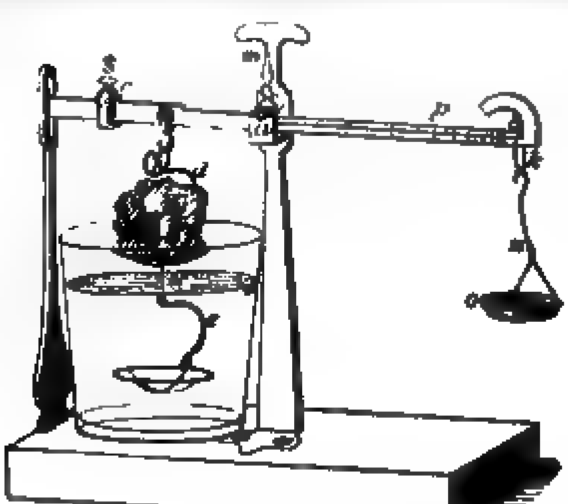
part of it was imbedded at the time of its fall, and the surface of that iron precludes the idea of its having been fused. If this generalization of iron be correct, it has an important bearing upon the hypothesis of the manner in which the Ovifak iron (supposing it to be meteoric) penetrated the basalt in scattered particles just at the time of the outflow of the basalt in a plastic state; for if the iron was not melted in its passage through the air, it could not have penetrated the basalt in such a manner that the particles are completely surrounded by terrestrial basalt. This fact in connection with many others lead me more and more strongly to the conviction, in common with some others, that the Ovifak iron is terrestrial.

On the whole, the iron just described is the most interesting specimen of meteoric iron yet known.

ART. XLVII.—*Specific Gravity Balance*; by ROSWELL PARISH.

THE specific gravity balance described below, is intended for the determination of the specific gravities of minerals, and of other solids heavier than water, without the use of exact weights and without mathematical computation.

The construction of this instrument is shown in the following figure. For use, the fine wire loop *k* with its attachments is removed, and the index *m* is adjusted to the middle line by means of the sliding cylinder with screw *c*.



The mineral (or other solid) is now placed in the wire basket *d*, which is suspended from the knife-edg *s* near *c*, and is counterpoised by the wire pan-holder *n*, one or more shallow metallic pans *o*, and a sufficient quantity of sand (or fine copper punchings), suspended by the wire loop *k* at the notch *b*, as shown in the figure.

The mineral is now transferred to the lower basket *e* (suspended from the upper by fine wire, and immersed in water), and the counterpoise *kno* is moved toward *a* until at some point as *p* it restores the beam to a horizontal position.

The specific gravity is then read off by means of the graduation upon the arm *ab*. This arm is graduated in accordance with the following considerations:

If the exact weight of the counterpoise *kno* be represented by x, then

$$\frac{x.ab}{as} = \text{weight of mineral in air.} \qquad (1)$$

Also $\frac{x.ap}{as}$ = weight of mineral in water. (2)

$$(1)-(2) = \frac{x.ab}{as} - \frac{x.ap}{as} = \frac{x.bp}{as} = \text{weight of water displaced.} \qquad (3)$$

$$(1)\div(3) = \frac{x.ab}{as} \div \frac{x.bp}{as} = \frac{ab}{bp} = \text{specific gravity of mineral.}$$

Hence the specific gravity is known if the ratio $\frac{ab}{bp}$ is known. This ratio is indicated upon the arm *ab* for as many points as possible.

An arm *ab* 12·6 inches long may be graduated to tenths as high as seven, while low specific gravities may be indicated with much greater exactness.

It will be seen that this balance does not determine weight, and that it renders mathematical computation unnecessary.

Worcester, Mass., Aug. 30, 1875.

ART. XLVIII.—*On Southern New England during the Melting of the Great Glacier*; by JAMES D. DANA. No. III.

III.—REINDEERS IN SOUTHERN NEW ENGLAND.

THE beds in the vicinity of New Haven pertaining to the Champlain or Fluvial period of the Quaternary have recently afforded remains of mammals. I am unable to prove positively that the species belonged to the earlier or "Diluvian" part of the period rather than the later or "Alluvian," and yet I deem this so far probable that I make this paper No. III, in the series on "Southern New England during the melting of the great glacier."

In a memoir on "The Geology of the New Haven region,"* I have described the clay deposits of the Quinnipiac valley between New Haven and North Haven; and on page 176 of this volume I have mentioned facts that appear to prove that they are of glacial origin, and were laid down before the glacial flood had reached its climax. As this clay has afforded the bones recently discovered I here briefly repeat the facts respecting its position and relations.

* Transactions of the Connecticut Academy, vol. ii, 1870, p. 84.

The Quinnipiac valley, south of North Haven village, is to a great extent a region of wet meadows and marshes, nearly five miles long and one broad, deep in peat, and mostly under water at high tide. The clay deposits occur for three and a half miles on both the east and west margins, sometimes extending laterally to the peat region there to stop suddenly, and sometimes graduating into sand-beds before reaching the peat. They are evidently, as I have elsewhere stated, local deposits in what were once still-water areas toward the sides of the wide Quinnipiac basin. The clay-bed seldom reaches more than six feet above high-water level, and is usually covered by four to five or more feet of sand or gravel of the stratified drift. The thickness is over 35 feet at Crafts' clay pit near the Quinnipiac station, two miles south of North Haven, but near the northern limit of the basin, a quarter of a mile south of North Haven, at the Stiles clay pit, only 15 to 18 feet.* The underlying bed, when examined, is of fine sand, called by the workmen "quicksand." The clay is regularly laminated, with the laminæ half an inch to an inch and a half thick; but each lamina really consists of two—one, of the finest "fatty" clay, and the other, lighter in color, of a more or less sandy clay—evidence of alternations of quiet and flowing waters during the progress of the deposition.

Mr. S. P. Crafts, the proprietor of a clay-pit at the village of Quinnipiac†—whose intelligent interest in the geology of the region has kept him on the lookout for fossil leaves and bones, glacial bowlders, and whatever would illustrate the origin of the deposits—has recently brought me from his pit two bones, the second within the month past. One of the bones is a humerus and the other a tibia. The humerus was taken from a depth of 11 feet in the clay bed, and the tibia, subsequently, at a [redacted]

men, and agrees so closely with the corresponding bone of
European Reindeer (*Rangifer tarandus*) that it must have
ged to the same or a very nearly related species. Its
mblance to the tibia of the American Caribou (*Rangifer*
m) is much less marked. The humerus also evidently
ged to a Reindeer, but the proportions are somewhat simi-
those of the Caribou."

th bones when found were without a trace of wear or frac-
The tibia had lost much of its gelatine and has hence
ne somewhat cracked from drying since it was exhumed.
humerus has almost the freshness and firmness of a recent
Both are of a light brownish color from their long
l. The difference in the conditions of the two bones Mr.
s explains by saying that the humerus was imbedded in the
ated clay, and the tibia in a portion of the clay-bed con-
ng sandy seams an inch or so thick, and open therefore to
lating waters. Besides relics of mammals, the clay beds
afforded no organic forms either vegetable or animal.
microscope reveals nothing.

e bones give us an insight into the life of New England in
arly part of the Quaternary, proving that Reindeers of
rctic type were living here. From the facts we gather

—

The bones are probably not of pre-Glacial age. They are
inly not bones which the glacier had taken up from the soil
neath it along with moraine material for transportation
deposition: this being evinced by their freedom from all
and fracture. The clay was produced through the glacial
ion of hard stones; and surely if the bones had been in
ame mill they would have been ground up too, or at least
l have been in some parts worn or broken. It is possible
hey were lying in the soil near by when the ice-period
, and that subglacial waters washed them into the basin
the depositing clay; but this is far from probable.

They were placed where they were found during the
tion of the clay bed, and were deposited at widely dif-
times, four feet in thickness of the clay intervening be-
n them. They therefore belonged to different individuals.

The clay bed is of glacial origin. For it contains an occa-
l bowlder of large size,* and is overlaid by sands and
l of the stratified drift.

If the reindeer bones were not pre-Glacial they must have
from reindeers living in the Quinnipiac valley after the
r had retreated to the north of the valley. And since the
bed is of glacial origin, its bowlders must have come
ice-floes that floated down stream from the retreated
r.

* This volume, page 177; the bowlder there referred to is of trap.

5. The clay beds of the Quinnipiac valley antedate the great flood due to the final dissolution of the glacier; for at the village of Quinnipiac the bed is overlaid on the west side by beds of coarse gravel, and just south of North Haven the sand and gravel overlying the clay bed has the flow-and-plunge structure so common in the stratified drift.

In my Memoir on the Geology of the New Haven region, I referred the clay-beds to the later or "Alluvian" part of the Champlain or Fluvial period, supposing them to be the mud-deposits made along the borders of the great Quinnipiac basin or inner New Haven harbor, during the more quiet portion of that era of submergence; and the sand-beds overlying and underlying the clay beds at North Haven I referred to the same time. But the discovery since then of the large bowlders in the clay beds,* and of evidence that the deposit of coarse stratified gravel situated along side of the clay pits actually overlies the clay in places, as proved by boring, appears to force us to the conclusion that the clay beds were (1) completed after the glacier had retreated from the valley, and (2) before the final flood.

6. Whether this retreat of the glacier was a *temporary* retreat, produced by a warm interval in the era of ice, or whether it was the *final* retreat, marking the progress of its final dissolution over New England, it is not easy positively to decide. The formation of stratified drift over the New Haven region has no break in the succession of its beds to mark such a retreat and return of the ice; and the clayey stratum contains no layer of vegetable or animal debris as testimony to a warm interval. All that the few facts suggest as to climate is that it was such as reindeers liked, which means that it was cold, and that the ice was still not far off to the north.

Remains of the Reindeer have been found in Northern New [redacted]

by the reindeer remains in Southern France. But they may, on the contrary, have belonged to the same time with the Reindeers of the Quinnipiac valley—the era of melting of the great glacier of the *first* glacial era.

The Stiles clay-pit, near North Haven, is reputed to have afforded many years since (as I state on page 86 of my Memoir on the New Haven Region) the antlers of a buck at a depth of 10 or 15 feet. Mr. J. Lorenzo Stiles informed me in 1870 that the antlers were those of the common species of deer. The specimen went to the New Haven City "Museum." The old museum long since disappeared, so that the fact with regard to the species cannot now be ascertained. The antlers may have been those of another Quinnipiac Reindeer.

ART. XLIX.—*Iowa County Meteor and its Meteorites*; by N. R. LEONARD.

ON the evening of February 12th, 1875, at about half past ten o'clock, a very large meteor was seen passing from S.W. toward the N.E., over Northern Missouri and Southern Iowa, and coming to the earth in the form of a shower of stones, in Iowa County, Iowa, a few miles east of Marengo.

At this hour the sky seems to have been quite clear over the greater part of the States named; though light clouds and a sort of haze are spoken of by observers in the counties adjoining the place where the stones fell, so that the meteor was seen throughout a region extending at least 400 miles in length from S.W. to N.E., and 250 miles in breadth.

In their descriptions of the course it pursued the accounts of observers varied with their positions with reference to the place where it fell. Those east of this region thought the course to be toward the west or northwest, those north described it as moving toward the south or the southeast, and in a few cases the statements of different observers in the same town are contradictory as to the direction of its motion.

The brilliancy of its light, and the concussion which accompanied its fall, were such as to attract very general notice, considering the lateness of the hour, and we believe that the observations herewith presented will be found to determine the path it pursued with a fair degree of accuracy.

I will give, first, those descriptions which relate to its general appearance, as nearly as possible in the language of the observers.

At Keokuk, Iowa, it is described as "Oblong in figure, with a train ten to twelve times the length of the body, giving an

intensely brilliant light, of crystalline whiteness at the center, fire red on the border, and throwing out red sparks and purplish jets of flame; train less luminous than body, exploded like a rocket. Opinions were divided as to whether any detonation accompanied the explosion." These observations were collected for me by L. C. Ingersoll, M.D., from a number of persons in that city who witnessed the flight.

At Washington, Iowa, Rev. E. B. Taggart in a letter to the Free Press of that city, describes it as of a "Horse-shoe shape, greatly elongated. The outer edge very bright, then a narrow dark space, with a core of intense brilliancy, so vivid as to blind the eyes for a moment. It had not a comet-like train, but a sort of flowing jacket of flame. Detonations heard, so violent as to shake the earth, and to jar the windows like the shock of an earthquake."

At Iowa Agricultural College, Prof. Macomber writes: "In form it was like an immense rocket with streamers flowing from the hinder part, the front being smooth and curved like a sabre. Its color was at first brilliant white, illuminating the sky like a flash of lightning; then fading gradually into yellow, then a deep rich orange, almost scarlet when it burst."

At Sigourney, almost directly under the path of the meteor, Mr. J. A. Donnell, writing to the "Sigourney News," speaks of it as "A globe of fire with pale lines of light radiating from it. The light of the globe very vivid. It appeared to be falling toward the earth from about 10° west of the zenith." He says he could see it dropping through a succession of clouds until it came inside the dome above him, where it apparently stood still for a moment and then passed over toward the northeast. The detonation was compared to the discharge of a 40 gun battery which he had heard in the army.

At Amana, about five miles northeast of the middle of the [redacted]

ie observers thought that the meteor attained its maximum rightness when about due west of that place. Some of the tudents who were familiar with the color of the flames of different ubstances with which they had experimented in the Chemical aboratory called out at the time that the color of the meteor howed iron and copper.

In computing the path pursued by the meteor I have relied lmost entirely upon observations which could be verified fterward, by reason of its having passed near to, or behind ome recognized point on a building or other object whose ltitude and bearing from the station of the observer have since een ascertained by instrumental measurement.

In giving the data I will denote the location of each observer y mentioning the section, township, and range numbers, which, as our lands are laid out on the rectangular method, will be quite definite.

The following is a list of observations upon which I have elied.

1. At Amana (northwest corner of 26–81–9). Mr. F. Chrisen first saw the meteor when at an altitude of 10 or 11 degrees nd at a bearing of S. 19° W. Soon after he saw it passing ear the top of a chimney whose bearing and altitude were espectively S. 26° W., and 17½° and finally saw it separate and lisappear at an altitude of 29° bearing S. 65° W.

2. At Mt. Pleasant (4–71–6), there is not a perfect agreenent as to the altitude of the meteor when due west of that lace. Some thought that it passed very near the moon, others hought that it passed above, and one at least gives its altitude s less than that of the moon. One observer spoke of seeing it when at a bearing of about S. 14° W.

3. At Albia, Monroe County (15–72–17), Mr. Pascal T. ambert saw it when due east at an altitude of 40° to 45°, and ointed out the place of its disappearance which I found to ave a bearing N. 41° 30′ E., or almost exactly in the direction f South Amana, in whose vicinity it fell.

4. Mr. E. H. Warrall of the U. S. Corps of Engineers at Keokuk, Iowa (24–65–5), gave its altitude when at a bearing f about N. 60° W., at between 10° and 12°.

Another observer gave the altitude when near the same lace at 10° 30′. Both observers saw the meteor disappear ehind a church steeple.

5. Rev. E. B. Taggart, of Washington, Iowa (17–75–7), hought that it passed 10° or 15° west of the moon.

6. Prof. J. K. Macomber of the Iowa State Agricultural College (4–83–24), first saw the meteor when at an altitude of 7° or 7° 30′ and bearing S. 55° E. This observation is almost exactly accordant with one taken independently at the same

place by a student who was engaged at the time in taking meteorological observations.

7. Mr. J. A. Donnell, of Sigourney (2–75–12), thought that the meteor passed about 10° west of the zenith of his place; no means of verifying his observation, and no measures taken.

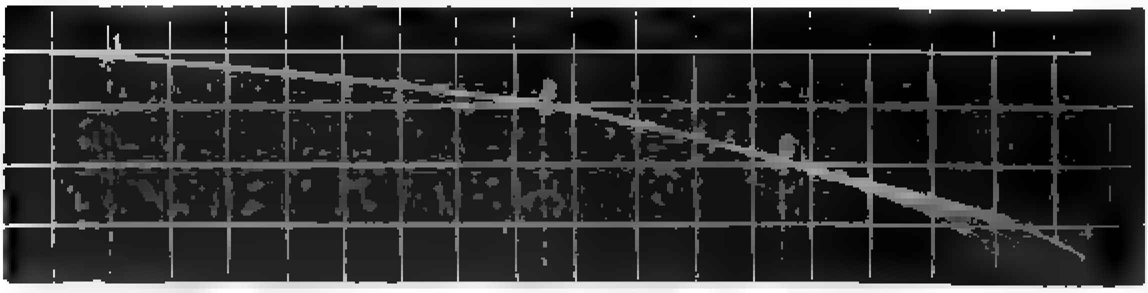
8. Mr. Ream, telegraph operator at Oskaloosa (13–75–17), gave the zenith distance of the meteor when due east as about 35°. No measures taken.

9. C. D. Leggett, Esq., of Fairfield (25–72–10), estimated its zenith distance, when northwest of him, at 25°.

From a comparison of observations 2 and 3, I conclude that the meteor passed over a point a few miles east of the town of Ottumwa. The course can be approximately marked on a map of the state by a line drawn through Agency City and South Amana, the latter being a little west of the center of the district over which the meteorites were found. This would give a bearing of about N 18° E., and would accord very well with the estimated zenith distances Nos. 8 and 9. It would, however, be at variance with No. 7, and the only explanation I can offer is by saying that it is very difficult for a man to fix, at a glance, the point directly over head, so that we may suspect this observation to be in error. No. 4 corresponds to a point about sixty eight miles from the place where the largest fragment was found, and gives for the altitude fifteen miles. No. 6 indicates a point thirty-eight miles from the same place, and gives for the altitude twelve miles. No. 1 indicates three points in the meteor path, the first nearly accordant with that given by No. 4, and gives about the same result as to height, the second point denoted is at a distance of about twenty-two miles from the end of the path, and at an altitude of eight miles; and the third point is two miles from the end of the path, and at an altitude of two miles.

Figure 1 shows these results to the eye. The sides of the squares are four miles. The points 1, 2, 3, and 4 are sixty-eight, thirty-eight, twenty-two, and two miles from where the largest stone fell. The heights at 1 and 4 of the figure I consider the most reliable; those at 2 and 3 are somewhat uncertain, owing to some uncertainty in the azimuth given by the observations.

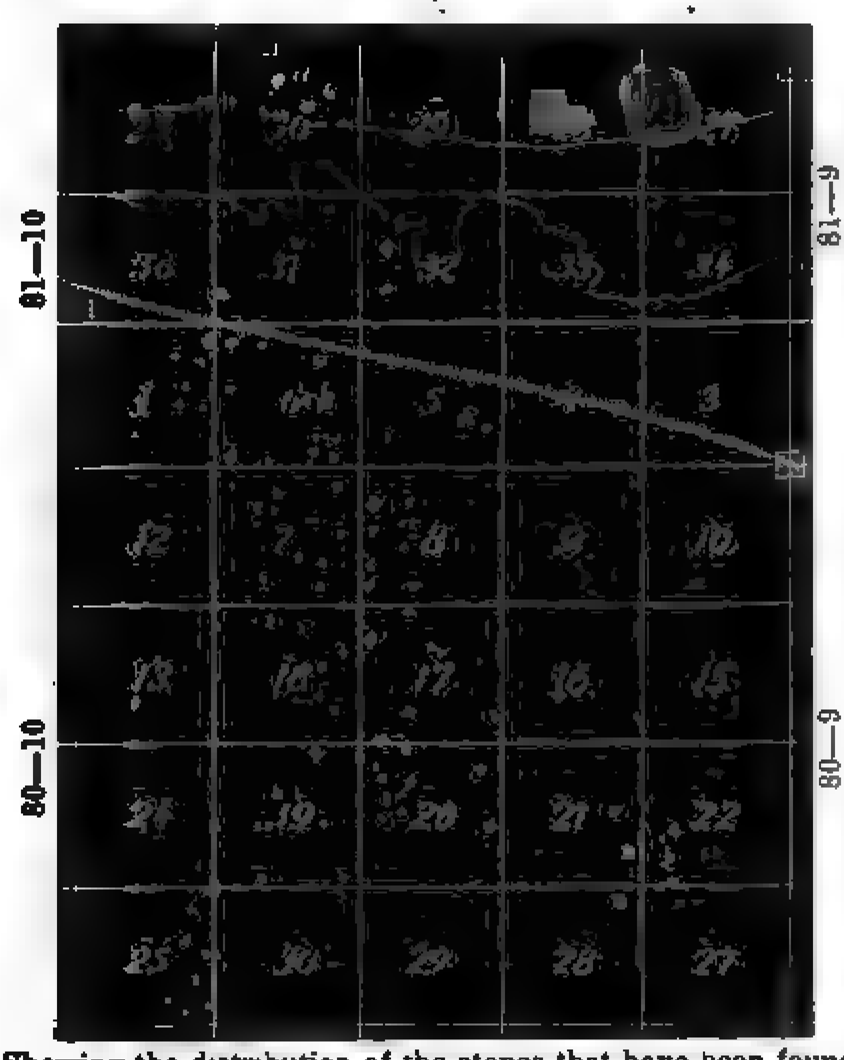
1.



Showing the path of the meteor through the atmosphere.

The product of this meteor-fall was a large number of irregularly shaped stones, varying in weight from a few ounces up to 74 pounds, and aggregating, so far as found, 500 pounds weight, of which I have secured more than 300.

Figure 2 shows the localities where the various fragments were found. The region represented is part of four townships near the northeast corner of Iowa County. The railroad is the Chicago, Rock Island & Pacific Railroad; the village in 36–81–10 is South Amana; that at northeast corner of 10–80–9 is Homestead; that in east line of 27–81–9 is Amana; and that in 28–81–9 is Middle Amana.



Showing the distribution of the stones that have been found.

The dots represent places where fragments have been picked up. We specially note—

a. in 5–80–9, where the first was found,	weight,	7 lb. 6 oz.
b. " 6–80–9, broken in striking the ground,	"	43 lb. 8 oz.
c. " "	"	15 lb.
d. " 30–81–9, lately found,	"	74 lb.
e. " " "	"	48 lb.

The largest quantity was probably found in the vicinity of 6-80-9, many pieces in that region weighed 8 to 14 pounds; not many small stones in that locality. Below sections 7 and 8 they were all small. The length of the field is about 7 miles, and its extreme breadth at the southern end about 4 miles.

It is worthy of remark that the regions bordering close upon the river are timbered land, and that especially in sections north of the river and below the two larger stones found, the lands are low and now overflowed, so that larger pieces, hidden by forest or water, may yet be found.

These meteoric stones are many of them entirely covered with the ordinary black coating, and they all present the "pitted" appearance common to such bodies. In several instances there is plain evidence of a fracture having taken place while the stone was as yet some distance from the earth.

These surfaces of fracture are for the most part covered with a secondary coating which sometimes appears to have been partially formed by the pouring over of the melted surface matter from other parts of the surface. In some cases, however, the overflow is only traceable to a short distance from the edge of the fracture, and the remainder is merely discolored as if by smoke.

The want of homogeneity in the structure of the aerolites is shown in several cases, by a sort of beaded circlet surrounding the stone. These circlets are composed of molten drops of iron and seem to lie nearly in a plane, and where this plane has been broken across in the fall, it may be traced over the fresh surface by the presence of unusually large particles of nickeliferous iron. For the following chemical analysis of a fragment of the meteorite I am indebted to Prof. J. Lawrence Smith.

Analysis of Prof. J. Lawrence Smith.—The Iowa County meteorite is of the more common variety, with a dull black coating, and having a rather light gray color in the interior. It has numerous particles of nickeliferous iron disseminated through it, also particles of troilite. The specimen analyzed had a vein running through it which was much richer in iron than the mass to which it belonged.

This meteorite has a hardness rather above the average of its class. I have found it to be composed of

Stony Matter,	81·64
Troilite,	5·82
Nickeliferous iron,	12·54

Of the stony part there was

Soluble in acid,	54·15
Insoluble,	45·85

Separate analyses of these gave for the

	Soluble.	Insoluble
Silica,	35·61	55·02
Protoxide of iron,	27·20	27·41
Magnesia,	33·45	13·12
Soda with traces of potass, and lithia,	1·45	2·01
Alumina,	·71	·84

This plainly shows that the principal constituent of the soluble portion is an olivine, rich in oxide of iron, approaching hyalosiderite in composition, and that the insoluble part is a pyroxene.

The nickeliferous iron contained, besides traces of phosphorus, sulphur, and copper,

Iron,	89·04
Nickel,	10·34
Cobalt,	·58

From an examination of an entire stone sent me after the completion of the above analysis, I have found the specific gravity to be 3·57. J. LAWRENCE SMITH.

Louisville, Ky., April 15th, 1875.

The first stone from the meteor that was found was discovered lying on the snow, on the afternoon of February 15th, and was adherent to snow and ice underneath. As the weather had been very cold from the time of the meteor-fall to the time of finding this fragment it must have been warm enough when it fell to melt slightly the underlying snow, to which it was afterwards frozen.

I visited the spot shortly afterward and found that it had first struck the ground more than 30 feet to the southwest of the place where it was found, making a slight indentation and bounding thence to the place where it finally came to rest. It was a fragment and showed a secondary coating of rather more than average thickness.

The other meteoric stones were not found until after the melting of the snow in the latter part of March. It is doubtless owing to the frozen condition of the ground and the low angle of descent that only a few of the larger pieces made any indentation in the earth, and we may therefore suppose that a much larger proportion of this meteor-fall has been secured than is usual.

The velocity with which the meteor moved cannot be satisfactorily stated. The maximum velocity, according to the data in my possession, would be about ten miles per second; the minimum about three miles. The most probable value for the last sixty or seventy miles of its course is from six to seven miles per second. This estimate was furnished by Mr. Christie, of Amana, who happened to be walking rapidly at the time the meteor appeared, and continued for a distance of fourteen paces, when having passed the corner of a building that threatened to obstruct his view, he stopped, and watched the meteor until it disappeared, and gave his estimate of the whole time at ten to twelve seconds; and as he saw it through sixty or seventy miles of its path, the resulting velocity would be as above stated.

Iowa State University, Aug. 4th, 1875.

ART. L.—*Brief Contributions to Zoology from the Museum of Yale College.* No. XXXVI.—*On the Post-pliocene fossils of Sankoty Head, Nantucket Island;* by A. E. VERRILL; *with a note on the Geology;* by S. H. SCUDDER.

AN account of the beds at Sankoty Head, with a list of the fossils obtained, was published by Messrs. Desor and Cabot in 1849,* and most of our knowledge of the locality has hitherto been derived from their description.

During the past summer the headquarters of the U. S. Fish Commission were at Wood's Hole, Mass., where an excellent and permanent biological station has been established under its auspices. In connection with the investigation of the marine invertebrates it was considered desirable to examine the fossiliferous deposits to ascertain the facts in regard to the former distribution of the species, and the physical changes that have occurred on our coast. Accordingly one of our dredging parties, consisting of Prof. A. Hyatt, Mr. Sanderson Smith, Mr. C. H. Merriam, and others, visited the locality, while on one of the excursions to Nantucket Shoals, and made a collection of the fossils. Later Mr. S. H. Scudder, of Cambridge, Mass., with the kind coöperation of Mr. W. J. Flagg, made an excavation into the cliff, so as to expose the fossiliferous beds more fully, and Mr. Richard Rathburn visited the locality, and made for the Commission, a large and very valuable collection of the fossils, in which the specimens from the lower and upper beds were kept distinct. Some of our most interesting results have been due wholly to the care with which he made and labelled this collection. From it we learn that the two layers, though only a few inches apart, contain very different assemblages of fossils and were deposited under quite different circumstances; the lower bed contains only such southern species as now inhabit the warm quiet waters of sheltered bays on the southern coasts of New England and farther south; while the upper bed contains many northern species, many of them fragmentary and beach-worn, and all of them, with one unimportant exception, the same species that are now found cast upon the outer beaches of Nantucket and Cape Cod by storms, and living in the colder outer waters, off the same coasts.

In the list published by Desor and Cabot seventeen species were enumerated, and those from the different beds were not kept separate. In our collections there are about sixty species,

* Quarterly Journal of the Geological Society of London, vol. v, p. 340, Feb. 1849. An abstract of the article has been printed by Dr. Packard in the Memoirs of the Boston Soc. of Nat. History, vol. i, p. 252, 1866. See also Proc. Boston Soc. Nat. Hist., vol. iii, p. 79, and this Journal, II, xiv, 50.

nearly all of which can now be assigned to their actual positions in the strata.

Mr. Scudder made a study of the stratification, and as his observations do not agree perfectly with the account given by Desor and Cabot, he has kindly furnished the following description of the locality. The most important point from which it differs from the former one is his conclusion that the fossiliferous beds are conformable to the strata of sandy clay, forming the base of the cliff. Mr. Desor stated that they are unconformable, and referred the clays to the Miocene Tertiary, like those of Martha's Vineyard.

Note on the Post-pliocene Strata of Sankoty Head; by S. H. Scudder.

"The sands and gravels forming the bluff at Sankoty Head, Nantucket, rest at base upon a thick bed of light brown sandy clay of uncertain thickness, but extending upward to about twenty feet above the sea-level. As the beds which rest upon it dip to the southwest, and as the anchor brings up clay from Sankoty Head eastward for half a mile, this clay bed is probably of great thickness.

The brown clay is overlaid by four feet of gravel and coarse sand, the coarser parts mostly confined to three or four inches of the uppermost levels; the upper bed is more or less ferruginous and hardens on exposure into a rather compact conglomerate. To this stratum must doubtless be referred a single specimen of a bivalve (probably a Mactra), with valves half open, picked up on the bluff, imbedded in a gravel conglomerate, and like it strongly impregnated with iron. The gravel is followed by about four feet of sands, subdivisible into separate beds, viz: at base, an inch or two of a very fine loose white sand, followed by nearly two feet and a half of a little less fine, closely packed, white sand, with irregular ferruginous streaks through its mass; this is covered by nine inches of a coarse beach sand, with a still coarser sand in pockets; and this again by nine inches of a very fine white sand. Above this comes a foot of ferruginous sand closely packed with masses of tough blue clay, much exceeding the sand in bulk, and forming the floor of the fossiliferous beds.

These consist first, at base, of twenty-two inches of coarse sand in which the oyster, quohog, and common clam are the prevailing forms, the first predominating to such a degree as to make the name of oyster-bed the most appropriate. This merges into a serpula-bed, about twenty-eight inches in thickness, made up almost altogether of large masses of serpula, packed in sand and almost wholly devoid of other fossils. The bed of worn shells superimposed on this is about twenty-two inches in thickness and closely resembles *coquina*, except in the entire want of adhesion between the fragments.

This bed is followed by about ten feet of fine white thinly bedded sand, and this by the stratified drift of the island, to a

depth, as estimated by Desor and Cabot, of forty-two feet; the foot of peat mentioned by them is wanting at this exact locality, (though present a few hundred feet farther south,) leaving the drift covered by five or six feet of dune-sand, more or less intermixed with loam below.

On following the bed of broken shells along the face of the cliff it was found to thin out to about a foot in thickness twenty-five feet on either side of the most prominent point, where the section was made,* and which has doubtless been longer protected than the other parts of the bluff by the former presence of a great mass of clay next the water's edge, called "Antony's Nose"; beyond these twenty-five feet, the bed of broken shells becomes more or less obscured by an admixture of sand, gravel and serpula, and is entirely lost at forty feet distance on either side.

The strata, from the lowermost clay to the bed of worn shells, all dip to the southwest. The uppermost beds incline along the face of the cliff three (3) degrees to the south, while the inclination to the west (along the section dug out of the cliff) is eleven (11) degrees, making a dip of nine (9) degrees to the southwest. All the beds below this also incline eleven (11) degrees to the west, but the inclination of their face toward the south increased gradually in passing downward, until that of the upper edge of the lower clay reaches eleven (11) degrees, making a southwesterly dip of this bed seventeen (17) degrees to the southwest. There is no evidence of any thinning out of the gravel-bed, as stated by Desor and Cabot, nor of any unconformability between this bed and the underlying clays; but, on the contrary, every appearance that the latter belong to the same continuous series as the former.

It is worthy of note that the fossils of this locality lie above the clays, instead of in the clays, as in most of the New England localities of post-pliocene marine shells."

Mr. Rathburn informs me that in the lower shell-bed the shells are extremely abundant and mostly entire, but generally break in pieces when the matrix is removed, and that when first taken out they appear to be soft, but harden on exposure to the air. The matrix is a coarse yellowish ferruginous sand with small pebbles, and the shells have a rusty stain. None of the specimens give any evidence of having been worn by the waves, and many of the most delicate, like *Cumingia tellinoides*, *Angulus tener*, etc., are entire, and sometimes have the valves still united. This is the case, also, with some of the oysters A large proportion of the quohog-clams (*Venus mercenaria*) are broken into angular fragments with sharp edges and angles. I have ascertained by an examination of large numbers of specimens, both entire and broken, that the breaking is due wholly to lines of fracture developed in the shell by drying or weath-

* I must here express my indebtedness to William J. Flagg. Esq., of New York, who freely gave me the unlimited assistance of his workmen, and enabled me to make a much more thorough exploration than could otherwise have been possible.

ring, just as similar shells often crack into angular fragments n the dry heated air of our museums. Many of the entire specimens of the fossil quohogs, etc., show such fractures extending in different directions across the shell, so that they are ready to break up into several angular fragments under the least strain, or even by a change in the moisture or temperature. This condition of fossil shells is a very frequent one in other localities, and will account for very many cases where the shells are found broken into angular fragments in rocks of other periods. It is evident, both from the condition of the shells in the lower bed and from the peculiar assemblage of southern species, that it was deposited in the very quiet waters of a sandy sheltered bay, entirely protected from the action of the oceanic waves. The assemblage of species is similar to that now living in the protected bays of Southern New England at the depth of 3 to 5 fathoms.* The quohog-clam, oyster, *Modiola hamatus*, *Cumingia tellinoides*, *Arca transversa*, *Urosalpinx cinerea*, and the three species of *Crepidula* are the most abundant and characteristic shells.

The Serpula bed consists mainly of convoluted masses of the tubes of *Serpula dianthus* V., mixed more or less with sand, but without many other fossils. This *Serpula* is still abundant all along the coasts of Southern New England, and southward to the Carolinas, in all sheltered bays and harbors where the water is not brackish, from low-water to 8 fathoms or more. It is often particularly abundant on oyster-beds, and in such localities often completely overgrows the shells, if neglected for a year or two.

The upper shell-bed, according to Mr. Rathburn, consists almost wholly of broken shells, with a little quartzose sand, which is light colored, and not at all ferruginous so that the shells from this bed are not stained rusty yellow by the oxide of iron, like those of the lower one. Many of the fragments are distinctly water-worn and rounded, and most of them have the appearance of those shells thrown on the outer beaches by the surf, or of the dead shells often dredged up in large quantities on sandy bottoms in shallow waters near the shore, or in the vicinity of sand-shoals, where the waves break during storms. The abundance of northern forms, such as *Buccinum undatum*, *Ceronia arctata*, *Astarte castanea*, *Cyclocardia borealis*, *Mya truncata*, *Balanus porcatus*, etc., shows that the bed was

* That the depth could not have been less than 3 fathoms is probable because those species that abundantly inhabit the eel-grass (*Zostera*), which grows in sheltered localities at all depths down to about 2½ fathoms, are either rare or entirely absent, viz. *Bittium nigrum*, *Astyris lunata*, *Triforis nigrocincta*, *Lacuna vincta*, *Littorina rudis*, *Pecten irradians*, etc. That the depth was probably not above 5 or 6 fathoms, I infer because the quohog and oyster, when adult, are seldom found in any abundance below 5 fathoms.

deposited by the cold waters of the outer coast, and their water-worn condition proves that the deposit was made in very shallow water near the shore, or near sand-shoals, swept by the waves. Such deposits may be made at any depth less than about 12 fathoms, but are more commouly made in 2 to 8 fathoms, on our coast.

This locality shows, therefore, that although important changes in the distribution of the land and water, as well as in the level of the land, must have occurred in this region during the time when these strata were being deposited, and subseqently, the temperature of the waters must have been nearly the same then as it is now. and that there must have been, at that time, the same contrast that now exists* between the coldness of the waters on the outer shores and the heat of the sheltered bays and harbors. The fossils of the lower bed indicate, for the water, a summer temperature of 70° to 75° F., while those of the upper bed correspond to a temparature of 55° to 60°, thus showing plainly the influence of the Arctic current along the coast. All the species still inhabit the waters of Southern New England, except *Diodora Noachina* found in the upper bed, but this occurs in Massachusetts Bay, and will probably be found hereafter in the deeper channels among the Nantucket Shoals, where we found this year many northern species that had not

* The nature of the changes that caused the alteration of the temperature and difference of the life indicated by these two beds of fossils will be discussed elsewhere more fully. It may be well, however, to state that my conclusion is that when the lower shell-bed and serpula-bed were forming, a shallow bay existed at this place, from which the outer waters were excluded, either by an island to the eastward of the site of Nantucket, or else by a southward prolongation of Cape Cod. The extensive submerged shoals south of Cape Cod and east and southeast of Nantucket may be the remnants of such lands. Some of these shoals are now covered with stones and rocks (probably drift boulders). Before the deposition of the upper bed some portion of the dry land eastward of the locality must have been submerged by subsidence, or else washed away by the encroachment of the sea (the latter most probably, to judge from the nature of the fossils), thus allowing the cold outer waters to occupy the bay, and the Atlantic surf to fill it with broken shells and beach sand. The protecting land must have been at least 50 feet higher, in its lowest parts, than the present level of the sea. As the shoals east of Nantucket have now several fathoms of water over them a vast amount of denudation must have taken place since that time. This is also shown by the great thickness of the strata of sand and gravel resulting from that denudation, and still remaining above the fossiliferous beds, and doubtless these strata have themselves also suffered great denudation during the period of their emergence from the sea, and subsequently. The partial destruction of islands formerly existing in the region of Nantucket Shoals would also result in partially filling the channels and deeper depressions between them, the final result of surf-action being a levelling one, and this would have been the case both during the period of submergence, and subsequently during that of emergence, but during the period of greatest depression (100 feet or more below the present level) there would have been comparatively little denudation of the deeply submerged islands, but there may have been islands high enough to have been out of water even then, which have since disappeared by denudation. The same reasoning will also apply to St. George's Bank and the great shoals adjacent, all of which are probably islands which have been worn down by the waves below the level of the sea.

·eviously been found south of Cape Cod. *Modiola hamatus*, hich occurs in considerable numbers in the lower bed, is a ›uthern shell, common in the Gulf of Mexico, and on the ›uthern coast as far north as Virginia, but occurring on the ›uthern coast of New England, only locally, in harbors, etc., ıd generally on beds of oysters that have been transplanted om farther south. For this reason it has been generally sup- ›sed that it is not indigenous but has in all cases been intro- ıced with the oysters. However this may be now, it is evi- ›nt that it was a native species in Post-pliocene times.

The only species that shows any noteworthy variation, when ›mpared with the modern shells from the same region, is the ıohog (*Venus mercenaria*). Most of the specimens of this spe- es differ considerably, in the rounder form, thicker shell, and ı the greater development of the concentric ridges, from the ·dinary quohog-clams seen in our markets. In a lot of large ıells of this species obtained from a fisherman at Nantucket, ıis season, there are many that are equally massive and have ıe same rounded form, and although the concentric sculp- ıre is not so strongly developed as in many of the fos- l shells, there is a decided approach toward them in this spect also. These living Nantucket quohogs certainly re- ·mble the fossil ones more closely than do those from any ;her locality known to me. But among the fossil specimens s also among the recent ones from Nantucket) there are some ·ecimens that are as smooth, thin and elongated as the ordi- ıry variety found in our harbors; and intermediate specimens so occur, so there is no reason to suppose that the variation in e fossil shells was anything more than a local variation, such often occurs in many species at the present time. Never- eless it may be convenient to designate such special condi- ›ns of a species by a particular variety-name. The general ·sence of such variations in the Post-pliocene shells of the ew England coast, as compared with those now living upon is certainly very remarkable, considering their great anti- ıity and the many important changes that have since taken ace in the physical conditions of the land and water. Such stances give us the best evidence in regard to the constancy d stability of true specific characters, even when apparently little or no importance in the economy of the animal itself.

List of Species from the lower Shell-bed.

The names of the species are those used in the Report on the .vertebrata of Southern New England, by the author and ·of. S. I. Smith, in 1st Report of the United States Com- issioner of Fish and Fisheries, 1874.

In each case the relative abundance is indicated. I have also added the present distribution on the American coast, in a general way, as well as a few notes on the geological distribution of each species. Fuller information on the distribution of the species has been given in the Report referred to.

MOLLUSCA.

Tritia trivittata Adams. Common.

Florida to Gulf of St. Lawrence; low-water to 40 fathoms. Fossil in the Post-pliocene of Point Shirley, Gardiner's I., Virginia and southward; in the Miocene of Maryland, South Carolina, etc.

Ilyanassa obsoleta Stimpson. Common.

Florida and Gulf of Mexico to Southern Maine; local in the southern part of the Gulf of St. Lawrence; littoral to 2 fathoms. Fossil in the Post-pliocene of Point Shirley, Virginia, South Carolina, etc.

Urosalpinx cinerea Stimpson. Common.

Tampa Bay and Eastern Florida to Massachusetts Bay, and local farther north to Gulf of St. Lawrence; littoral to 10 fathoms. Post-pliocene fossil at Point Shirley, Gardiner's I., Virginia and southward; in the Miocene of Maryland.

Eupleura caudata Adams. One fine specimen.

Gulf of Mexico and Eastern Florida to Cape Cod; low-water to 8 fathoms. In the Post-pliocene from Virginia to Florida; Miocene of Maryland and South Carolina.

Astyris lunata Dall. One specimen.

Alabama and Florida to Massachusetts Bay; low-water to 14 fathoms. Fossil in the Post-pliocene of Gardiner's I and South Carolina.

Cerithiopsis Greenii Verrill. Four specimens.

South Carolina to Massachusetts Bay; two to 10 fathoms.

Crepidula fornicata Lamarck. Abundant.

Gulf of Mexico to Southern Maine, and local in the southern part of the Gulf of St. Lawrence; low water to 15 fathoms. Post-pliocene fossil at Gardiner's I., South Carolina, etc.; and Miocene in Maryland and South Carolina.

Crepidula plana Say. Common.

Distribution same as the preceding, from which, however, it is very distinct.

Crepidula convexa Say. Not common.

Distribution like the two preceding, from both of which it is perfectly distinct (although confounded with *C. fornicata* by Tryon and others). Fossil in the Post-pliocene of Virginia and South Carolina.

Odostomia trifida Gould. Common.

New Jersey to Massachusetts Bay; low-water to 5 fathoms.

Odostomia impressa Stimpson. Common.

South Carolina to Vineyard Sound; low-water to 5 fathoms.

Turbonilla interrupta Adams. Several specimens.

South Carolina to Cape Cod; local farther north to the southern part of the Gulf of St. Lawrence, near Prince Edwards' Island; low-water to 15 fathoms. Post-pliocene fossil at Gardiner's I. and in S. Carolina.

Saxicava arctica Deshayes. Rare and small.

Arctic Ocean to Georgia, local and rare south of Long Island; low-water to 50 fathoms. Fossil in the Post-pliocene of Maine and everywhere northward.

Mya arenaria Linné. Abundant.

Arctic Ocean (lat. 78° N.) to South Carolina; low-water to 40 fathoms. Post-pliocene fossil from South Carolina and Virginia to Greenland and Northern Europe.

Corbula contracta Say. One valve.

Florida to Cape Cod.

Ensatella Americana Verrill. Common.

Labrador to Florida; low-water to 25 fathoms. Fossil in the Post-pliocene of Portland, Me., Point Shirley, Gardiner's I., Virginia and South Carolina; Miocene of Maryland, etc.

Angulus tener Adams. Several specimens.

Florida to Gulf of St. Lawrence; low-water to 12 fathoms.

Cumingia tellinoides Conrad. Common.

Florida to Cape Cod; three to 12 fathoms. In the Post-pliocene and Miocene of South Carolina, etc.

Petricola pholadiformis Lamarck. Rare.

Gulf of Mexico to Massachusetts Bay; local in Casco Bay and southern part of the Gulf of St. Lawrence; low-water to 4 fathoms. In the Post-pliocene and Pliocene from Florida to Virginia.

Venus mercenaria Linné. The variety abundant; a nearly typical form not uncommon.

Florida to Massachusetts Bay; local on the southwestern coast of Maine and southern shores of the Gulf of St. Lawrence and Bay of Chaleur; low-water to 8 fathoms. In the Post-pliocene of Point Shirley, Gardiner's I., Virginia, Florida; Miocene from Maryland to South Carolina.

Var. antiqua Verrill. By this name I propose to designate the unusually massive and strongly sculptured variety to which most of the fossil shells belong, and which has been already discussed on a previous page.

The shell is rather obtusely rounded posteriorly, and is thickly covered with prominent concentric lamelliform ridges, which mostly extend entirely across the shell, but are often reflexed, appressed and more or less confluent over the middle region, where the ordinary variety is nearly smooth (except

when young). The violet color can still be traced in some specimens entirely around the inner margin, as in many recent Nantucket examples.

Tottenia gemma Perkins. Few specimens obtained.

South Carolina to Labrador; low-water to 4 fathoms.

Gouldia mactracea Gould. One specimen.

Florida to Cape Cod; 3 to 15 fathoms.

Scapharca transversa Adams. Very abundant and large.

Florida to Cape Cod; low-water to 15 fathoms. In the Post-pliocene of Cape Cod, Gardiner's I., Virginia, South Carolina; Miocene of Virginia and North Carolina.

Mytilus edulis Linné. Common.

Circumpolar; Arctic Ocean to North Carolina; littoral to 50 fathoms. In the Post-pliocene from Florida to Greenland and Northern Europe.

Modiola hamatus Verrill. Common.

Gulf of Mexico to Long Island Sound and Naragansett Bay; littoral.

Crenella glandula Adams. Few specimens obtained.

Labrador to Long Island; 5 to 60 fathoms. In the Post-pliocene of Montreal.

Anomia glabra Verrill.

Florida to Cape Cod; and locally farther north to Nova Scotia; littoral to 20 fathoms. In the Post-pliocene and Pliocene of South Carolina.

Ostrea Virginiana Lister. Abundant and well-grown.

Gulf of Mexico to Cape Cod, and locally farther north, at Damariscotta, Me., and in the southern part of the Gulf of St. Lawrence; low-water to 5 fathoms. In the Post-pliocene of Point Shirley, Gardiner's I., South Carolina, etc. Both the short, rounded specimens and the much elongated and narrow forms occur, as well as all the intermediate states, just as in many modern oyster-beds, showing that in Post-pliocene times the same kind of individual variations prevailed that have perplexed many modern systematists, but they have not yet become specific, nor even definite varietal characters.

BRYOZOA.

Hippothoa variabilis V. (*Escharella variabilis* Verrill, in Report on Invert.) Common on *Serpula*, etc.

Florida to Massachusetts Bay; low-water to twenty fathoms.

Biflustra tenuis V. (*Membranipora tenuis* (Desor); Verrill, in Report on Invert.) Common on shells.

Delaware to Massachusetts Bay: low-water to 15 fathoms.

Membranipora catenularia Smitt. Common on shells.

Arctic Ocean to Long Island Sound; low-water to 50 fathoms; northern Europe.

CRUSTACEA; ANNELIDA; PORIFERA.

Panopeus, sp. Several claws were found.

Eupagurus pollicaris Stimpson. A claw, probably from this bed, is recorded by Desor.

Florida to Massachusetts; 2 to 15 fathoms.

Balanus eburneus Gould. Common.

West Indies to Massachusetts Bay; littoral to 3 fathoms.

Balanus crenatus Bruguiére. Common.

West Indies to the Arctic Ocean; 3 to 15 fathoms.

Serpula dianthus Verrill. Very abundant.

North Carolina to Cape Cod; low-water to 15 fathoms.

Cliona sulphurea Verrill. The excavations are abundant in oyster shells.

Florida to Massachusetts Bay; 1 to 15 fathoms.

*List of Species found only in the upper Shell-bed.**

Buccinum undatum Linné. Common.

Arctic Ocean to New Jersey; northern coasts of Europe; low-water to 100 fathoms. In the Post-pliocene, Maine to Labrador and Northern Europe.

Neptunea curta Verrill. Several specimens, one of large size.

Labrador to Massachusetts Bay, and in deep water farther south, to Long Island.

Lunatia heros Adams. Common, but badly broken.

Georgia to Gulf of St. Lawrence; low-water to 40 fathoms. Post-pliocene, Canada, S. Carolina; Pliocene, S. Carolina; Miocene, Maryland to S. Carolina.

Var. triseriata. One specimen occurred.

Neverita duplicata Stimpson. One broken specimen.

Yucatan to Massachusetts Bay; low-water to 10 fathoms. Post-pliocene, Virginia to Florida; Pliocene, S. Carolina; Miocene, Maryland to S. Carolina.

Crucibulum striatum Adams. One large specimen.

New Jersey to Bay of Fundy; low-water to 40 fathoms.

Scalaria Grœnlandica Perry. Recorded by Desor, and doubtless from this bed.

Arctic Ocean to Block Island; 10 to 109 fathoms; Northern Europe. Fossil in Post-pliocene of Northern Europe.

Diodora noachina Gray. Two good specimens.

Arctic Ocean to Cape Cod; 8 to 70 fathoms; northern Europe.

Mya truncata Linné. Several large specimens.

Arctic Ocean to Nantucket Shoals; low-water to 10 fathoms; northern Europe. In the Post-pliocene, Maine to Labrador.

Thracia truncata Mighels and Adams. A few valves, special bed not indicated.

Greenland to Long Island; 10 to 60 fathoms.

* A valve of *Saxicava Norvegica* was found after this list was put in typ Arctic Ocean to Massachusetts Bay.

Clidiophora trilineata Carpenter. One valve.

Florida to Gulf of St. Lawrence; low-water to 30 fathoms.

Macoma fragilis Adams, *var. fusca* (Say). A few valves.

Greenland to Georgia; littoral to 6 fathoms. In Post-pliocene from S. Carolina to Greenland.

Ceronia arctata Adams. Abundant and large.

Gulf of St. Lawrence to Long Island.

Mactra solidissima Chemnitz. Common, fragmentary.

Florida to Labrador; low-water to 12 fathoms. Post-pliocene of Point Shirley, Mass.

Cyclocardia borealis Conrad. Common.

Labrador to New Jersey; 3 to 80 fathoms. In the Post-pliocene of Gardiner's I.; Point Shirley; Labrador.

Cyclocardia Novangliæ Morse. A few valves.

Gulf of St. Lawrence to Long Island Sound; 3 to 40 fathoms.

Astarte undata Gould. One worn valve.

Long Island Sound to Northumberland Straits in Gulf of St. Lawrence; low-water to 100 fathoms. In the Post-pliocene of Gardiner's Island and Point Shirley.

Astarte castanea Say. Abundant.

New Jersey to Nova Scotia; 5 to 40 fathoms. In the Post-pliocene at Point Shirley.

Modiola modiolus Turton. Many worn valves.

Circumpolar; Greenland to New Jersey; low-water to 80 fathoms. In the Post-pliocene of Point Shirley, Canada, and northern Europe.

Anomia aculeata Gmelin. Common

Arctic Ocean to Long Island Sound; low-water to 100 fathoms.

Bryozoa.

Eschara verrucosa Esper. On shells of Ceronia.

Arctic Ocean to Nantucket Shoals; 3 to 45 fathoms. Northern Europe. In the fossil examples the surface of the cells is covered with radiating ridges, often rising into an eminence in the middle, and is perforated with numerous pores in the grooves. Orifice somewhat semicircular with a median avicularium in front of the proximal edge.

Celleporaria incrassata Smitt (?). Several.

Off Martha's Vineyard to Spitzbergen; 10 to 160 fathoms. The specimens are thick, irregular masses. The apertures are small, rounded, oblong, constricted on the sides by small points projecting inward near the middle, and sometimes with a small proximal spine.

Crustacea and Echinodermata.

Balanus porcatus. Very abundant and large, but broken.

Arctic Ocean to Long Island Sound; 2 to 90 fathoms.

Strongylocentrotus Dröbachiensis A. Agassiz. Spines only. Arctic Ocean to New Jersey; circumpolar; low-water to 430 fathoms. Post-pliocene of Maine and northward.

List of Species found in both Shell-beds.

	Lower Bed.	Upper Bed.
Urosalpinx cinerea	Common.	One.
Tritia trivittata	Few.	Common.
Ilyanassa obsoleta	Few.	Few.
Crepidula fornicata	Abundant.	Few.
Crepidula plana	Common.	Few.
Ensatella Americana	Abundant.	Few.
Mya arenaria	Abundant.	Few.
Saxicava arctica	Few.	Common.
Venus mercenaria	Abundant.	Few.
Scapharca transversa	Abundant.	Few.
Mytilus edulis	Few	Common.
Crenella glandula	Few.	Several, large.
Ostrea Virginiana	Abundant.	Few.

Most of these belong to the fauna of the warm sheltered bays, and their occurrence in the upper bed may have been accidental in many cases. The few worn shells of such species, though found in the upper bed, may have been originally deposited in the lower one and afterward washed out by the waves and redeposited in the upper one.

The absence of many species ordinarily abundant in the clay-beds of our New England Post-pliocene, (e. g., the species of *Nucula*, *Yoldia*, *Leda*, etc.), is doubtless due to the fact that such species lived only on muddy bottoms, while both of these deposits were made on sandy bottoms. They are, in fact, characterized by the nearly complete absence of all true muddy-bottom species.

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *On Trimethyl-carbinol, and its supposed occurrence among the products of Fermentation.*—In examining a crude fusel oil, obtained from a manufactory of potato-spirit, which contained only a small quantity of amyl alcohol, Freund converted the isobutyl alcohol, boiling between 107° and 110°, which was principal product, into isobutyl chloride by heating with fuming hydrochloric acid in sealed tubes. Beside this substance, which boiled between 66·5° and 69°, 120 grams of a chloride boiling at 50°–53° was separated; and this on being heated with water in sealed tubes for ten hours gave trimethyl-carbinol, distilling from 82° to 85°, and solidifying on cooling. It was at first supposed, that as Butlerow has stated, this tertiary alcohol was contained in the crude product, being a product of the fermentation;

but the improbability of the existence of at least 12 per cent of this substance in a most carefully fractionated product such as was used in preparing the chloride, when it had a boiling point lower by 25°, led to the supposition that the trimethyl-carbinol was produced from the isobutyl alcohol itself, by the action of the hydrochloric acid. Pure isobutyl alcohol was taken and heated as above with hydrochloric acid; the tertiary chloride was obtained and converted into the alcohol by the action of water. Further experiments showed that the quantity produced depends on the relative amount of hydrochloric acid; and that hydrobromic and hydriodic acids act similarly. The reaction is as follows:—

$$
\begin{array}{cccccccc}
 & \mathrm{H} & \mathrm{OH} & & & \mathrm{I} & \mathrm{H} & \\
\mathrm{CH_3}- & \mathrm{C}- & \mathrm{CH_2} & +\mathrm{HI}= & \mathrm{CH_3}- & \mathrm{C}- & \mathrm{CH_2} & +\mathrm{H_2O} \\
 & \mathrm{CH_3} & & & & \mathrm{CH_3} & &
\end{array}
$$

The author recommends this reaction for the preparation of trimethyl-carbinol. Isobutyl alcohol is saturated with HCl, five parts fuming acid are added, and the whole is heated in a water-bath for 24 hours.—*J. pr. Ch.*, II, xii, 25, July, 1875. G. F. B.

2. *On the Preparation of Epichlorhydrin.*—Prevost recommends, instead of treating dichlorhydrin by potassium or sodium hydrate in the cold, as in the usual method for the preparation of epichlorhydrin, to warm the dichlorhydrin in a roomy retort with a receiver attached, to a temperature not exceeding 130°, and to add sodium hydrate gradually; 250 grams being taken for 550 c.c. of dichlorhydrin. At the given temperature the epichlorhydrin distills over with the vapor of water. The process is more rapid and the yield is much larger than in the one formerly employed.—*J. pr. Ch.*, II, xii, 160, July, 1875. G. F. B.

3. *On Three new Pinacolins.*—The name pinacolin was given by Fittig to a body obtained by dehydrating pinacone, and extended by Butlerow to a class of acetones which contained tertiary-alcohol radicals. Pinacolin itself according to Butlerow is methyl-trimethylcarbyl-acetone, $C(CH_3)_3$–.–CO–.–CH_3. Wischnegradsky, under this chemist's direction, has prepared three new bodies belonging to this class, two of which are isomeric and contain seven atoms of carbon while the third contains eight. If one molecule of trimethyl-acetyl chloride be added carefully to two of zinc-ethyl, a violent reaction takes place and a solid substance is obtained having an odor like camphor and like mint, and a specific gravity of 0·831 at 0°. Analysis showed it to be ethyl-butyl-pinacolin, having the rational formula $C(CH_3)_3$–.–CO–.–C_2H_5. The other bodies were obtained by the action of ethyl-dimethyl-acetyl chloride upon zinc-methyl and zinc-ethyl respectively. The first is methyl-amyl-pinacolin, $C(C_2H_5)(CH_3)_2$–.–CO–.–CH_3, isomeric or rather metameric with ethyl-butyl-pinacolin, and having a boiling point 6·5° higher. The second is ethyl-amyl-pinaco-

lin, $C(C_2H_5)(CH_3)_2$-·—CO—·—C_2H_5, having a specific gravity of 0·845 at 0° and boiling at 150·5° to 157·5°. By the oxidation of these pinacolins, they are split up, the CO group remaining with the tertiary radical. The author is continuing the investigation.—*Liebig's Annalen*, clxxviii, 103, Aug., 1875. G. F. B.

4. *Salylic acid identical with Benzoic.*—In 1860, Kolbe and Lautemann reduced chlorsalylic acid with sodium amalgam and obtained an acid which they called salylic acid, and which, though the formula was identical with that of benzoic acid, the authors believed, on account of the behavior of the acid and its salts, to be only an isomer of this acid. This opinion having been called in question by Reichenbach and Beilstein in 1864, who obtained benzoic acid by distilling salylic acid with water, KOLBE has re-examined the question more thoroughly, using for the reduction a kilogram of chemically pure chlorsalylic acid. A heavy sandy crystalline powder without odor was obtained entirely different in appearance from benzoic acid, as was also its lime salt. But on distillation with water pure benzoic acid went over, leaving in the retort a minute quanity of a pale yellow greasy substance. That this was the cause of the differences observed was proved by again mixing it with the benzoic acid; on crystallization the form of salylic acid returned. It hence appears that only benzoic acid is produced in the reduction of chlorsalylic acid; and that a quantity of some fatty body, produced during this process, so minute as not to affect the analytical results, is capable of altering the entire external appearance of the product. Treatment with permanganate also removes the impurity and yields pure benzoic acid; possibly by oxidizing the reduction product to benzoic acid.—*J. pr. Ch.*, II, xii, 151, July, 1875. G. F. B.

5. *On the Reduction-product of Chlordracylic acid.*—Inasmuch as Kolbe had shown in the above paper that the reduction-product of chlorsalylic (metachlorbenzoic) acid was benzoic acid, it occurred to HARTMANN that the same fact might be true of chlordracylic acid (parachlorbenzoic acid). The acid was prepared by the action of phosphoric chloride upon paraoxybenzoic acid. The product of its reduction was benzoic acid, disguised as before by the presence of some tarry substance.—*J. pr. Ch.*, II, xii, 204, Aug., 1875. G. F. B.

6. *Use of Salicylic acid in Titrition.*—WEISKE proposes to replace the usual litmus solution in titrition by salicylic acid. The acid is dissolved in water, filtered, and to the solution a few drops of ferric chloride is added. To the intensely colored solution, very dilute soda solution is added carefully from a burette to exact neutralization, whereby the liquid becomes reddish-yellow. If now a few cubic centimeters be added to the liquid to be titered, the latter remains uncolored. But as the point of neutralization is reached by the addition of the soda solution, the liquid acquires a deeper and deeper violet tint, which suddenly and immediately disappears again when the soda is added in the slightest excess. The final reaction is sharp and the results are much better than with litmus.—*J. pr. Ch., II*, xii, 157, July, 1875. G. F. B.

7. *On the Synthesis of Malonic acid.*—PINNER some time ago showed that when zinc and hydrochloric acid acted on trichlorlactic acid there was produced, not monochlorlactic acid, but, by the loss of a molecule of water, chloracrylic acid. He now finds that if ethyl chloracrylate be boiled with barium hydrate, there is formed in considerable quantity a difficultly soluble barium salt, which yields an acid crystallizing from ether in large prisms and identical with malonic acid. It fuses at 132° and yields salts identical with those of malonic acid. The author represents the reaction in three stages: 1st. The replacement of the chlorine by hydroxyl producing acryl-lactic acid:—

$$CHCl{=}CH{-}COOH + HOH = CH(OH){=}CH{-}COOH + HCl$$

2d. The addition of a molecule of water and then by rearrangement forming malonic aldehyde:—

$$CH(OH){=}CH{-}COOH + HOH = CH(OH)_2{-}CH_2{-}COOH$$

$$CH(OH)_2{-}CH_2{-}COOH = COH{-}CH_2{-}COOH + HOH.$$

3d. By oxidation giving $COOH{-}CH_2{-}COOH$, malonic acid. —*Ber. Berl. Chem. Ges.*, viii, 963, July, 1875. G. F. B.

8. *On the Action of Chlorine on Pyrogallol.*—STENHOUSE and GROVES have investigated the action of chlorine on pyrogallol. When an acetic acid solution of this substance is saturated with chlorine in the cold, it becomes of a pale orange-red color. It is then placed in water at 70° for 20 minutes, the chlorine being continued, then rapidly cooled and a third of strong hydrochloric acid added, the chlorine continued for an hour, and the whole allowed to stand for 24 hours. Crystals are obtained which when purified appear as brilliant orthorhombic prisms insoluble in water, soluble freely in ether, and affording on analysis the empirical formula $C_{18}H_7Cl_{11}O_{10}$. To this substance the authors give the name mairogallol. If a solution of pyrogallol in acetic acid be saturated with chlorine in the cold as above, then concentrated hydrochloric acid added and a rapid current of chlorine passed through it, it effervesces strongly and in a few minutes solidifies to an orange-colored mass. After purification, crystalline crusts are obtained consisting of minute colorless radiating needles, easily soluble in water and alcohol and affording on analysis the formula $C_{18}H_6Cl_{12}O_{12}+(H_2O)_2$. This the authors call leucogallol. It is quite unstable. *Jour. Chem. Soc.*, II, xiii, 704, Aug. 1875. G. F. B.

9. *On the Constitution of Emodin.* Emodin is a constituent of rhubarb-root discovered by De la Rue and Müller in 1857. LIEBERMANN has succeeded in determining its rational constitution. The material operated on was obtained from Trommsdorff, in the preparation of chrysophanic acid. Heated with zinc dust, emodin yielded a hydrocarbon closely resembling anthracene but having a higher fusing point. Oxidation with chromic acid gave a white product soluble in concentrated sulphuric acid, which after precipitation passed only slowly into alizarin on fusion with potash. Treatment with acetic oxide gave two products: one in

-yellow plates, the other in bright yellow needles. These es proved to be mono- and tri-acetyl-emodin and led to the ula $C_{15}H_{10}O_5$ for emodin itself. It differs from purpurin in ng CH_2 more; or in having a methyl group in place of H. e the hydrocarbon which it yields is not anthracene but me-anthracene. This was proved by finding that it gave anthra-one-carbonic acid on oxidation. From these data, Liebermann ludes that emodin is a tri-oxymethylanthraquinone of the wing formula:

$$C_{14}H_5\begin{cases}CH_3\\(OH)_3\\COOH.\end{cases}$$

as now undertaken the examination of chrysophanic acid, h appears to be similar, being dioxymethylanthraquinone. *er. Berl. Chem. Ges.*, viii, 970. July, 1875. G. F. B.

. *On the Coloring Matters Phlorein, Hæmatein and Brazi-*—BENEDIKT has succeeded in producing from phloroglucin a ing matter which shows a marked analogy with those of log-l and Brazil wood. This substance, which he calls phlorein, repared by the action of nitrous acid dissolved in nitric upon roglucin dissolved in ether. On distilling off the ether a nificent violet semi-fluid residue remained, which, on adding r, was precipitated in red-brown light flocks. It was puri-by reduction, and was obtained as a dark green powder with a g metallic luster, nearly insoluble in boiling water, but solu-in alcohol, ether, and acetic acid with a deep brown, and in lies with an intense purple color. Owing to the difficulty of ombustion, its nitrogen was at first overlooked. The empiri-formula $C_{18}H_{11}NO_7$ is assigned to it, the rational formula ded on this, deriving it from ammonia

$$N\begin{cases}C_6H_2\begin{cases}OH\\OH\\O\end{cases}\\C_6H_2\ \{\ OH.\\C_6H_2\begin{cases}O\\OH\\OH\end{cases}\end{cases}$$

great similarity of phlorein to hæmatein and brazilein led the or to prepare these bodies and to analyze them. He found that both contained nitrogen, hitherto overlooked, and were other-similarly constituted. He writes phlorein as $3(C_6H_5O_3)N$ $(_2O)_2$, hæmatein as $3(C_{16}H_{13}O_6)N$ and brazilein as $_8H_{17}O_7)N$. Phlorein, however, yields a hydroderivative.—*ig's Annalen*, clxxviii, 92, Aug., 1875. G. F. B.

. *Arithmetical relations between the Atomic weights.* Note rof. IRA REMSEN, addressed to one of the editors, dated Wil-stown, Mass., Oct. 11, 1875.—In the last October number of American Journal of Science there is contained an article by). C. Hodges, entitled, "On the Arithmetical Relations be-n the Atomic Weights," in regard to which I venture to offer nark. The subject treated in the article is undoubtedly of in-

terest, and some credit is due Mr. Hodges for his apparently independent discovery of the relations described. I think, however, that a certain amount of credit should also be given to those who first called attention to these relations.

In the Annalen der Chemie und Pharmacie (VIII Supplement, S. 133) there is a masterly article by D. Mendelejeff in which the same subject is discussed that is discussed in Mr. Hodges's paper. Every relation referred to in the latter paper is made use of in the former paper, together with a great many beautiful relations which do not seem to have occurred to Mr. Hodges.

The subject of Mendelejeff's paper is: "The periodical law of the Chemical elements." Under this head he discusses the following subjects:

(1.) The nature of the periodical law.

(2.) On the application of the periodical law for the purpose of systematizing the elements.

(3.) Application of the periodical law for the purpose of determining the atomic weights of elements which have not been studied exhaustively.

(4.) Application of the periodical law for the purpose of determining the properties of undiscovered elements.

(5.) On the application of the periodical law for the purpose of correcting atomic weights determined by other means.

(6.) On the application of the periodical law for the purpose of enlarging our knowledge of chemical structural forms.

The same subject, further, has also been fully discussed from another standpoint by Lothar Meyer, both in the Annalen der Chemie und Pharmacie (VII Supplement, S. 354), and in his work entitled: "Die modernen Theorien der Chemie."

In a work by H. Baumhauer ("Die Beziehungen zwischen dem Atomgewichte und der Natur der chemischen Elemente") another exhaustive discussion of the same subject may be found.

Mr Hodges appears to have overlooked the above-mentioned memoirs.

12. *Compressibility of Carbonic Acid.*—Dr. Andrews, in a recent paper before the Royal Society, gives a continuation of his well known paper published in 1869, "On the Continuity of the Liquid and Gaseous States of Matter." A series of accurate measurements have been made of the corresponding temperature, pressure and volume of carbonic acid, to test the correctness of the laws of Boyle, Gay Lussac and Dalton. The apparatus employed was essentially the same as before, the chief improvement being in the method of ascertaining the volume of the gases before compression. The lower ends of the glass tubes containing the gases dip into small mercurial reservoirs formed of thin glass tubes, which rest on ledges within the apparatus. The leather washers used in packing the fine screws are now saturated with grease by heating them *in vacuo* under melted lard. The air enclosed in the pores of the leather was thus removed without the aid of water. This packing has never been known to fail in a

el filled with water. But with mercury it always yields after w days, even under a pressure of 40 atmospheres. Unfortely, the pressures must still be given as determined by an or hydrogen manometer, as the only satisfactory method of icing to absolute pressures would be by a mercury column, ch, for the highest pressure would have to be over 1,200 feet 1. Recently, however, a method has suggested itself by ch it will probably be possible to measure pressures up to 500 even 1,000 atmospheres directly in terms of a liquid column. pressure required to produce liquefaction is given for various peratures between 0° and 30° C., and agrees well with the ilts of the earlier measurements. The pressures are somewhat than those given by Regnault, which were probably effected the unavoidable pressure of air.

he compressibility was carefully measured at temperatures of , 63·7° and 100°, the two latter temperatures being obtained surrounding the apparatus with the vapor of methyl alcohol water, and the pressure being carried to over 200 atmosres. The results fully confirm those previously attained to effect that its volume at high pressures and temperatures ve the critical point is much less than that it should have if a ect gas. Even at 100° the volume of 223 atmospheres is only ut three-fifths of that given by the law, hence we may infer analogy, that the critical points of the gases not yet liquefied probably far below the lowest temperatures yet attained.

he law of Gay Lussac, while doubtless nearly true for the alled permanent gases, is far from correct for gases at high ssures or near their critical points. The coefficient of expan- of carbonic acid under 1 atmosphere being ·0036, under 22 ospheres it was ·0055 between 6° and 64°, and ·0051 between and 100°. The corresponding coefficients for a pressure of 31 ospheres were ·0068 and ·0059, and at 40 atmospheres ·0095 ·0072.

very large number of experiments were made on mixtures of onic acid and nitrogen, and the most important result was the critical point is lowered by admixture with a noncondensable gas. Thus a mixture of 3 parts by volume of caric acid with 4 of nitrogen was reduced below −20° C. before densation took place, even at the highest pressures. Even an ition of one-tenth its volume of nitrogen or air will materially er the critical point. Finally, it appears that the law of ton is wholly incorrect at high pressures when one of the es is not far from its critical point. This accounts for the erved anomalies in the tension of aqueous vapor when alone when mixed with air, which are not accounted for as has 1 alleged by the hygroscopic action of the containing vessel. *Vature*, xii, 300. E. C. P.

3. *Magnets formed of Iron Filings.*—M. Jamin has repeated experiment of De Haldat, in which a brass tube was filled with filings and magnetized. The polarity was slight, not sensi-

bly increased when the stoppers closing the ends were tightened, and diminished slowly when sand was mixed with the filings. This observation is accurate but imperfect. In repeating it the filings were forcibly compressed by a small hydraulic press. When they begin to aggregate, the polarity is seen to augment considerably, and continues to increase with the pressure. Tubes were shown to the Academy from 8 to 10 cms. long and 3 cms. in diameter, which attract at least as many steel filings as pieces of good steel of the same dimensions. As the filings were of unknown origin some were prepared from very soft iron, perfectly reduced and without appreciable coercive force. The results were quite equal to the former. Here then is a metal which has no coercive force when it is continuous, but acquired a coercive force equal to that of steel when we reduce it to minute fragments, and then make them contiguous by pressure. Must not the polarity observed be attributed to this discontinuity? and is not the coercive force of steel to be explained by the same cause?

The distribution of the force in a magnet cannot be accounted for without regarding it as composed of rows of minute magnetic elements with opposite poles reacting on each other at a distance; and it is verified that the quantities of separate magnetism in each of them are increased by this reaction, from the extremity to the middle line (*Lamé Physique*, iii, 100). Up to the present time it seems to have been assumed that these elements are the molecules themselves; the preceding experiment seems to show that they are formed either by fragments of iron in proximity to one another, or by minute crystals agglomerated as in steel.

When before pressing the filings we interpolate among them substances which render the mass more homogeneous, the same polarity cannot be given as when they are unmixed. For example, by making a paste of chloride of iron and the filings, and rubbing it, we obtain, after a few days, a subchloride continuous in appearance, capable of being filed and polished like pure iron, but hardly magnetizable.

Iron reduced by hydrogen, and scales of oxide of iron, behave like iron filings; but magnetic and diamagnetic substances mixed with the filings alter notably the faculty they possess of being magnetized. The study of all these circumstances promises interesting researches. It is probable that by greatly increasing the compression of the powders the coercive force will be found to increase to a maximum, and afterward diminish when the approximation of the fragments has restored a sufficient degree of continuity to the mass.—*Comptes Rendus*, lxxxi, 205; *Phil. Mag.*, l, 255. E. C. P.

14. *Sounding Flames.*—M. C. Decharme finds that persistent and varied sounds may be obtained by allowing a current of air to impinge on a jet of common illuminating gas issuing from a tube 3 to 5 mms. in diameter, and forming a flame 30 to 50 cms.

igh. The air is conveyed in a similar tube, and the character of ıe sound will vary according to the part of the flame struck, the ressure of the air and the ratio of the diameter of the tubes.

When the jet of air, striking the flame near the top, gradually escends to within about a decimeter of the orifice, we see the olumn of flame first divide, lower itself, then twist under the jet, nvelop it and let it pass, surrounding it with a blue flickering ame; a continuous tearing sound is then heard from this lumious vail. When the jet reaches within 2 or 3 cms. of the orifice f the gas (the air tube being held horizontally and being irected toward the flame) a loud hissing is produced. Finally, 'hen the tubes touch, the hissing becomes harsher, or if the ressure is small, becomes a very clear and agreeable musical ound.

The experiment also succeeds well with a Bunsen burner, after losing the air holes. It is needless to add that no sound is proucd with the simple gas jet if not lighted. By varying the onditions, as the nature and pressure of the gas and air, the osition, diameter, form and nature of the tubes, various modifica.ons of the sounds, and of the shape and color of the flame are roduced. The rapid motions are readily analyzed by a revolving ıirror. It would appear that the explanation of these facts epends not merely on the mechanical, but in a great measure on ıe chemical action of the air.—*Comptes Rendus*, lxxx, 1602.

E. C. P.

II. Geology and Natural History.

1. *Evidence of glacial action upon the summit of Mt. Washıgton, N. H.*—Prof. C. H. Hitchcock has recently given the etails of the discovery of transported bowlders upon the summit of It. Washington, 6,293 feet above mean tide water, in a paper ead before the American Association for the Advancement of cience at Detroit. The following are the essential points of the ommunication. The bowlders do not exceed six inches in length far as observed, and consist of the "Bethlehem gneiss" of the '. H. Reports, and must have been transported more than a ozen miles. They occur in the usual *moraine profonde* of the 'orthern drift and have the peculiar shapes common to glaciated ones, but do not well retain any glacial markings upon them. fter observing that most of the angular blocks upon this summit est upon this drift containing transported bowlders, the author omes to the conclusion that the greater part of the angular ebris upon this mountain, though of the same material with ıe ledges, has been transported by the glacial agency from a w rods to three miles. Subsequently the frost has shattered ıem into angular fragments nearly covering the surface. Wherer ledges occur the same agency has broken off large masses hich cannot be distinguished lithologically from those that may ıve been transported a considerable distance. Most of this ıgular debris is so far removed from existing ledges that frost

and gravity alone cannot have placed them where they now are though many of the piles are thus explicable. The ledges have their northwestern sides rounded and the southeast angular just like the striated bosses near the Lake of the Clouds.

Earlier observers have failed to discover these facts because the far transported stones have been brought to light by recent excavations in the earth beneath the almost universal carpet of frost-cleft fragments.

2. *Report on the Geology and Resources of the Region in the vicinity of the 49th Parallel from the Lake of the Woods to the Rocky Mountains;* by G. M. Dawson, Geologist and Botanist to the Commission. 388 pp. 8vo, with a colored geological map, views and sections. Montreal, 1875. Addressed to Major D. R. Cameron, R. A., H. M. Boundary Commissioner.—This volume by an excellent geological observer, contains the results of an investigation of the Rocky Mountain formations north of and near the northern boundary of the United States, and is well illustrated by sketches, sections and maps. The author speaks first of the General physical geography and outline geology of the region, and then of the special geology of the Lake of the Woods, and the structure of the Rocky Mountains near the 49th parallel.

A large amount of facts are given respecting the Cretaceous and Tertiary strata, which will aid in settling doubtful points as to the distribution of the formations and as to the age of the Lignitic beds. Chapter VIII is devoted to this last subject, "the age of the Lignite-bearing formation and position of the line separating the Cretaceous and Tertiary," and the discussion is one of value as it comes from a careful worker over a new part of the Lignitic area. Many results of assays of the lignite are contained in a chapter on its economical value. Mr. Dawson discovered coccoliths and rhabdoliths in great numbers in the Cretaceous beds of Manitoba.

Chapters IX and X, 65 pages in length, treat of the Glacial phenomena and superficial deposits of the region examined, and Chapter XI of the Capabilities of the Region with reference to settlement. Following this there are Zoölogical Appendixes, Descriptions of fossil plants by Dr. Dawson, etc.

The Glacial facts collected are numerous and of wide import. The scratches over the region of the Lake of the Woods show that the movement of the ice there was in general *toward the southwest.* The courses, stated on page 205, vary from S. 5° W. to S. 87° W.; but the larger part are between S. 20° W. and S. 40° W. The author arrives independently at the conclusion, brought out by Major General G. K. Warren, that Lake Winnipeg formerly had a southern outflow—though differing from the latter in making this pre-Glacial in time. The author, to explain the glacial phenomena observed by him, supposes that the interior of the continent was under the sea, and that local glaciers and icebergs were the chief agents. He says that "the height of the highest terraces at the South Kootanie Pass is 4,400

;t, and I have little doubt but that these are of marine origin."
r. Dawson appreciates the objection to this view from the ab-
nce of all marine remains and of other results of marine action
at might, if such were the case, be reasonably looked for. He
pears to suppose that there is no alternative between the theory
marine submergence and that of a great Polar ice-cap. The
;ts he presents with regard to the southwest course of the gla-
il scratches about the Lake of the Woods in connection with
nilar facts about Lake Winnipeg, and Lake Huron, in Ohio, etc.,
int to another view more consistent with the earth's meteorologi-
l laws, viz: that the glacier had its greatest thickness not in a
›lar ice-cape, but toward the Atlantic border of the Continent,
nere the precipitation would necessarily have been the greatest;
at the upper surface of the ice sloped thence away southeastward
er New England, and southwestward over western New York,
iio, Lake Huron and the region north of Lake Superior to the
ıke of the Woods and Lake Winnipeg; that it thinned down to
thing over the great central and western area between 100° W.
d the Cascade Mountains of Oregon, where precipitation now
erages but one-third what it is on the eastern border and sum-
er heat is great, and had much thickness in these latitudes only
the Arctic; but that the Arctic would have had its precipita-
›n greatly diminished by the new conditions, and hence would,
rhaps, have had less ice than now; that the assumed ice-cape
ıs rather an ice-mantle thrown about the pole and descending
›ng the borders of the continent, especially the eastern. Add
;al glaciers about the mountains, the Appalachians on the east
d the various higher elevations on the west, and we have all the
; that is needed to explain the facts in North America upon the
sis of a Glacier theory. The above mentioned meteorological
nditions would have had special intensity, if the glacial cold
d the excessive glacial precipitation were due to the confine-
ent of the Gulf Stream with its heat to the temperate and tropi-
l North Atlantic by a shoaling of the ocean between Scandi-
via and Greenland. J. D. D.

3. *Report of a Reconnaissance of the Black Hills of Dakota
ıde in the summer of* 1874; by William Ludlow, Captain of
ıgineers, Lieutenant-Colonel U. S. A., Chief Engineer Depart-
ent of Dakota. 122 pp. 4to, with several maps. Washington,
75. Engineer Department, U. S. Army.—This volume consists
a General Report of the Expedition by Col. Ludlow; a Geo-
gical Report, with a list of Trees and Shrubs, by N. H. Win-
ell; a Paleontological Report, by G. B. Grinnell; descriptions
d figures of new Fossils, by R. P. Whitfield (including *Obolus
ctenoides* Whitfield, from Potsdam rocks on French Creek,
ıkota, *Terebratula Helena* Whitf., from the Cretaceous on the
rtheast side of the Black Hills); and Tables of observations for
ne and latitude. Of the maps in the volume one is a Geo-
gical map, by Professor Winchell, of the Black Hills on a
ale of 6 miles to 1 inch. The rocks described by Prof. Winchell

are the Cretaceous, the Jurassic and Triassic or Red bed
325 feet thick at the northern base of the Black Hills, a li
formation lying *unconformably* beneath the Red beds, v
Carboniferous at top and may include other formations,
Potsdam sandstone. Beneath the last are metamorphic
and slate with high angle of dip, and granite. We und
from Mr. G. B. Grinnell, that the credit of identifying th
mentioned in Prof. Winchell's Report should have been g
the latter to Mr. R. P. Whitfield, instead of to himself.

4. *Discovery of the Horns of an extinct species of Ox i*
—A few years ago some workmen digging in the gravel o
Creek, Adams County, O., preparatory to laying foundat
the abutments of a bridge, discovered a pair of enormou
about eighteen feet below the surface. On examination
found that they were only the *cores* of the original horns,
terior portion having perished. They measure nearly
from tip to tip, and are twenty-two inches in circumferen
the core of the horns of the ox is about one-third of th
length, these must have been of enormous size. They w
to Cincinnati, and have been kept in comparative obscuri
quite recently, when they came under the observation of I
ton, who obtained permission to exhibit them before the
History Society. The Society has since secured them.

5. *On the Mesozoic formation of Mexico and its ch
istic fossils;* by MARIANO BARCENA. 37 pp. 8vo. Mexic
—In this Memoir (in Spanish) Mr. Barcena treats of the c
tion of the Cretaceous rocks of Mexico, their kinds and t
sils. The rocks include limestones, part of them metan
different argillaceous rocks, micaceous, talcose and dioriti
and they are stated to constitute a large part of the m
elevations of the Mexican territory. The gray, compa
stones contain species of *Hippurites* and *Nerinea* in s
abundance that they are well called the Hippurite limest
Nerinea limestone of Mexico. The author describes and
two species of Hippurites, *H. Mexicana* and *H. calamit*
several species of Nerinea, and also species of Ammoni
Scaphites, and an Aptychus, *A. Arenassii.* The reason
ferring the rocks of different districts to the Cretaceous, a
cially to the Upper Cretaceous, are given at length by
cena, in the course of his Memoir. From the evidence i
cluded that Cretaceous rocks occur in all the Mexican
and the author consequently proposes that the map of
America in the Cretaceous period, which is given in Dan
ual of Geology should be changed, by making the area
taceous seas to extend from Texas westward to the
Ocean—the facts serving to prove that the Gulf of Mex
the Pacific were actually connected in the Cretaceous
The Cretaceous area thus added, as shown on a map acc
ing the Memoir, lies between a line from the Pacific to t
northeast in course, running nearly through Chihuahua,
other parallel through Vera Cruz. Its extension northw
and southeastward remains for future determination.

Mr. Barcena in another paper, published at Mexico in 1875, describes a fossil Sphæroma—*S. Burkartii*—from the valley of Ameca, Estate of Jalisco, which was obtained in an Artesian boring from beds that are probably Tertiary. No other fossils have been found at the place to fix the age; a figure of the species accompanies the paper. J. D. D.

6. *Mountain Making: The inequalities of the Earth's Surface viewed in connection with Secular Cooling.*—Mr. O. FISHER closes a mathematical discussion of this subject in the Cambridge Phil. Trans., vol. xii, part ii, with the following remarks:

Can we then attribute the intense corrugations which meet our observation to any other source than that of lateral pressure caused by a shrinking globe? It appears to me difficult to conceive any other. No local change in the condition of the superficial strata seems competent to produce a sufficient amount of extension in the superficial strata. I cannot perceive, as I have already endeavored to explain, how the deposition of thick beds upon the sea-bottom could affect it by their weight, and I have elsewhere, I think proved, that they could not do so by causing a new distribution of heat within the crust.* There is likewise much reason to believe that consolidation and metamorphism are accompanied by a contraction in volume.

The supposition that the earth became solid throughout, or nearly so, before a crust began to be formed, necesitates the consequence that the contraction, out of which the compression would arise, must be almost wholly confined to the cooled upper portion: it is upon this supposition that we have calculated its amount, and found it so much smaller than is warranted by natural appearances. If, however, we could suppose that a solid crust was formed upon the surface, long before its interior parts had fallen to the melting temperature, it seems that a much greater amount of compression might result, through the contraction extending far below the cooled upper portion. The objection made to this is, that the crust would break up as fast as it formed, and sink into the underlying fluid until the whole was brought to the melting temperature. But Mr. Mallet has shown, in the paper already more than once referred to,† that the difference between the specific gravities of solidifying and molten rock is so small, being scarcely six per cent, that when we consider the intermediate condition of viscosity, we need not assume this breaking up and sinking of the crust. And if in its early stages shrinkage cracks did form, it seems likely that the fluid which welled up into them would immediately solidify and seal them up. Scrope tells us that "the interior of a lava-stream often retains a very high temperature for a great length of time after its emission, continuing to send forth vapor from its crevices and fumeroles, and probably remaining liquid, and even more or less in motion, throughout its central and lower portion for years.‡"

* Geographical Magazine, vol. x, p. 248. † Phil. Trans. 1873, p. 160, § 60.
‡ Volcanoes, 2nd edition, p. 84, § 8.

Sir W. Thomson clearly contemplates the mode of solidifica tion from without inwards as not impossible, for he says "If ex perimenters will find the latent heat of fusion and the variation o conductivity and specific heat of the earth's crust up to its meltin point, it will be easy to modify the solution given above so as t make it applicable to the case of a liquid globe gradually solidi fying from without inwards in consequence of heat conducte through the solid crust to a cold external medium."

If this supposition is admissible, there may have been a consid erably larger nucleus enclosed within the crust in early time than we have at present, and a great portion of that nucleus ma have consisted in superheated water, the rocks being in a state o igneo-aqueous solution:* and much of this water may have bee blown off in steam during volcanic eruptions, by that means mate rially contributing to the diminution of the volume. I have sug gested in my former paper read before this Society, that Mr. Sorby' observations on the water enclosed in granitic crystals, along with crystals of chlorides, renders it probable that the steam emitted i eruptions may be a constituent part of the deep-seated rocks, fo it is probable that but a small part of the water contained in an magma would become confined in the interior of the crystals.

Here, however, the question arises whether it would be possibl for a crust to form over a layer of molten rock in a condition o igneo-aqueous fusion. Would not the escape of the water cause state of constant ebullition which would prevent the formation o any crust until it had ceased through the escape of water?

The idea of igneo-aqueous solution involves a condition of chem ical combination between the water and the elements of the rock such that while that condition lasted there would be no tendency to separation between the two, and evaporation would be in abey ance. We can therefore conceive that at depths where the heat and pressure were sufficient there might be no tendency to evapora tion and consequent ebullition, so that after the water had escaped to a certain depth ebullition would cease, and a crust be formed but that more water would be ready to separate to a greater depth when its affinity for rock became lessened through the abstraction of heat, or diminution of pressure owing to the crust being par tially supported by corrugation.

* The following remarks upon the above passage were received from a quarter which disposes me to place great reliance on them:

"It is probable, or rather certain, that water substance, if it exists at great depths under great pressure and at high temperature, is neither a gas nor a liquid, being above its critical point.

"In this state substances are easily dissolved in it, not however so much on account of a greater tendency to combine with water, as on account of a greater tendency of their own to dissipation. At still higher temperature the water sub stance becomes itself dissociated into oxygen and hydrogen. But it does not follow that the dissolved substances will be precipitated. The magma may be all the more complete the higher the temperature, because, though the bonds of affin ity have fallen away, the prison-walls prevent the elements from escaping. But of all the known regions of the Universe the most unsafe to reason about is that which is under our feet."

If such was the condition of the interior in the early stages of the cosmogony, a large portion of the oceans now above the crust may once have been beneath it, and thus we gain a novel conception of a sense in which the fountains of the abyss may once have been broken up.

A somewhat analogous escape of elastic vapor from beneath a denser envelope is I believe considered to be now taking place in the Sun.

The comparative small specific gravity of the earth as a whole, considering the great pressure to which its interior parts must be subject, has been held to prove that it is even now in a state of expansion through intense heat.*

But the question of its true condition is surrounded with difficulties. The supposition made by Sir Wm. Thomson of a cool nucleus covered by a sufficiently deep layer of molten rock is adopted by Dr. Sterry Hunt,† and would afford the conditions required by the argument of this paper. It would also afford the mean rigidity required to meet the objection to a fluid interior drawn from the absence of internal tides. But it would not account for the small specific gravity of the whole, nor yet would it meet the argument from precession in the form in which it was originally advanced by Mr. Hopkins: for a layer of fluid beneath the crust would destroy a rigid connection between it and the interior. This form of the argument however has been attacked, and apparently with some success.‡ The late Archdeacon Pratt, in defense of the general argument from precession, placed the matter in a simple light in a letter to *Nature* in 1871,§ and in that form I think it would be met by the supposition of a cool nucleus covered by a molten ocean with a solidified crust. But I would invite attention to the fact that the conclusions I have arrived at, concerning a highly fluid condition of the interior, have reference to an early period of its history; while the tests of the tides, and of precession, are confined in their application to the present. Nevertheless I am disposed to think that, at any rate, what may be termed a superheated condition of the mass still exists at no very great depth below the surface. By which I mean that if it be solid the solidity is due to pressure.

7. *Remarks on the Sedimentary Formations of New South Wales;* by Rev. W. B. Clarke, M.A., F.G.S., &c. Third edition, 62 pp. with geological sections. Sydney, New South Wales, 1875.—This memoir is a review of the geology of Australia by one who has worked long in geological investigations over New South Wales. The question of the age of the coal formation is fully discussed; and between the extreme limits adopted by different writers, the Jurassic period and the Lower Carboniferous, Mr. Clarke holds to his old opinion that they are of the latter age.

* Herschel's Phys. Geography, 2nd edit., p. 7.

† American Journal of Science, vol. v, p. 264.

‡ General Barnard on "Problems of Rotary Motion," Smithsonian Contributions, No. 240.

§ Nature, vol. iv, p. 344.

The writer in his Exploring Expedition Report (1849), on New South Wales, sustained the view that their age was half way between those extremes, or Permian, and this is adopted by him in the last edition of his Manual of Geology (1874, p. 370). The absence of Tertiary rocks from all of Eastern Australia is accounted for on the supposition that the eastern coast, since the Tertiary era, has subsided many fathoms, as indicated by the existence of the great barrier coral-reef off the coast, any Tertiary formations then formed having been thus submerged. J. D. D.

8. *Geological Survey of Brazil.*—Prof. C. F. Hartt, recently of the Cornell University, has been placed in charge of the Geological Survey of Brazil by the Emperor. It is reported that the survey is to be continued four years. Professor Hartt's previous explorations in Brazil, first in connection with the Thayer Expedition, have eminently fitted him for the work.

9. *Geologische Beobachtungen auf Reisen im Kaukasus*, von H. Abich. 138 pp. 8vo, with one chart. Moscow, 1875.—Prof. Abich, who has long been investigating the country of the Caucasus, here treats of the Geology of the Beschtau warm-spring formation; the North Caucasus Jurassic Coal formation; the Quartz-trachyte formation of Tschegem; and the Glaciers of the northern side of the Caucasus.

10. *Old beach on the Isle of Portland, near Weymouth, Southern England.*—Professor Prestwich describes a raised beach on the east side of the Portland Bell, its south extremity, from 24 feet to 30 feet above the present beach, near its northeastern extremity, and 53 feet at its northwestern. It contains numerous marine shells, the most of which are those of the adjoining seas, while a few belong some degrees farther north. The raised beach is capped by other beds of loam and rubble, in places 5 to 10 feet thick. At the Admiralty quarries, about 400 feet above the sea, a bed of drift has afforded some bones of Mammals—*Elephas antiquus* and *E. primigenius*, and species of *Equus*, *Cervus* and *Bos*. Prof. Prestwich closes his paper with a discussion of the geographical conditions under which the deposits were made.—*Q. J. Geol. Soc.*, Febr. 1875, p. 29.

11. *Another New York Mastodon.*—A skeleton of a Mastodon has been found at Lisle, near Binghamton, New York, and is being exhumed for the Museum of the Cornell University.

12. *Microscopical Structure of Rocks*, with plates 7, 8; and *Granitic and other Ingenite Rocks of Yar-Connaught and the Lower Oele*, with plates 9 to 12, and other papers; by G. H. Kinahan. From the Proceedings of the Roy. Irish Acad., II, vol. ii, Dublin, 1875. These papers contain valuable facts on the nature and microscopic structure of the rocks referred to in the title. The term *Ingenite*, meaning "born, bred, or created within or below," is from a paper, on *the Microscope in Geology*, by Mr. D. Forbes, published in the Popular Science Review for October, 1867.

13. *Elemente der Petrographie*, von Dr. A. von Lasaulx, A. ö. Prof. Min. Univ. Breslau. 486 pp. 8vo. Bonn, 1875. (Emil Strauss).—

escriptions in this work by Dr. Lasaulx are clear and con-nd generally include one or more chemical analyses. The ication is based first on (I) the fact of one mineral constitu · (II) many; and, under these heads, on texture, as non-lline or crystalline, etc. An introductory portion reviews ructure of rocks, and the character of their constituent min-and a closing chapter treats of the origin of rocks and rites. The work is handsomely printed on fine paper.

Minerals of Bourbonne-les-Bains.—In addition to the min-pecies of these hot waters mentioned on page 228 of this e, Daubrée has detected also the rare species *phosgenite* ide of lead), covered with a crust of mixed galenite and m; and, from the interior of a tube of bronze, a coating con-; of *atacamite.*—*L'Institut*, Aug. 4.

Mineralogische Mittheilungen; von V. RITTER V. ZEPHARO-VI, 1875.—This sixth number of the mineralogical contribu-by Professor Zepharovich contains descriptions of crystals of ite from Eisenerz and Hüttenberg, of native arsenic from imsthal, and a discussion of the crystalline form of cronsted-The aragonite crystals were remarkable in exhibiting a large er of planes, mostly in the prismatic zone, with abnormal nal indices, analogous to those long since described by ky. E. S. D.

Wiserine is Octahedrite.—Professor Klein, of Heidelberg, in nt valuable memoir on the crystallization of anatase (octahe-has shown that the wiserine (xenotime) from the Binnenthal, bed by Kenngott, is actually identical with octahedrite. He s, however, that true xenotime is found at that locality, but ystals do not agree with those described as wiserine.—*Jahrb.* 1875, 337. E. S. D.

Chalcophanite, a new mineral; by GIDEON E. MOORE, Ph.D. urs in druses of lustrous crytals, and in foliated aggregates, the walls of cavities or grouped in stalactitic forms; in the case the crystals are grouped around a central core of a man-rous mineral. The crystals are minute, but occasionally ntly distinct to admit of determination. Rhombohedral; ing planes O and R, the basal plane preponderating, the ls are sometimes in the form of thin scales. Measurements or $R \wedge R$ 114° 30′, and $O \wedge R$ 104° 13′ (required 103° 48′), e a=3·5267. Basal plane brilliant, rhombohedral faces often · striated. Cleavage, basal perfect; micaceous, the thin e slightly flexible. H.=2·5. G.=3·907. Luster metallic. bluish-black to iron-black. Streak chocolate-brown, dull. e. Before the blow-pipe turns to a yellowish-bronze or cop-l; exfoliates slightly, and on continued heating darkens in and fuses slightly on thin edges. With the fluxes gives a maganese reaction, and on charcoal with soda gives a coat-oxide of zinc. Soluble in hydrochloric acid.

lyses: 1, of distinct crystals; 2, of stalactitic aggregates sing a radiated structure. In the latter case the material was pure as that used in analysis 1.

		$\ddot{M}n$	$\dot{M}n$	$\dot{Z}n$	$\dot{F}e$	$\dot{H}$
1.	[illegible]	69·94	6·58	21·70	·25	11.68=100·05
2.	[illegible]	61·57	4·41	20·80	—	12·66

Analysis 1 gives for the oxygen ratio of peroxide, protoxides and water 4 : 1 : 2, and the same is obtained from 2 after making deductions for impurities present. This ratio gives for the formula $\dot{R}, \ddot{R}_2 + \dot{H}_2$, or more exactly $(\frac{1}{3}\dot{M}n, \frac{2}{3}\dot{Z}n), \ddot{M}n_2 + 2\dot{H}$. In this case one-half of the water is regarded as basic. It is thus closely related to wad and psilomelane.

Chalcophanite is a result of the decomposition of franklinite and associated minerals. Found at the calamine locality at Stirling Hill, Ogdensburg, N. J.

Named from χαλκός brass and φαίνω to appear, in allusion to the change of color which the mineral undergoes upon ignition.—*Am. Chem.*, July, 1875. E. S. D.

18. *Statistics of Mines and Mining* (*Sixth Annual Report*); by ROSSITER W. RAYMOND, U. S. Commissioner of Mining Statistics. 8vo, pp. 585. Washington, 1874.—Dr. RAYMOND'S Reports on the Mines and Mining in the States and Territories west of the Rocky Mountains now form a most valuable repository of scientific and technical literature on all topics germane to this subject. The present volume contains the usual data respecting the mining industry of the ten States and Territories enumerated for the year 1873, together with special chapters on the following subjects:—the Mining and Metallurgy of Quicksilver; Hints on the Washoe process; Smelting in Park County, Colorado; Lead and Silver Smelting in Chicago; the Wyandotte Smelting and Refining Works; the Smelting Works of the Harz; the desilverization of Lead by Zinc; avoidable Wastes of American Smelting Works; Kustel's Roasting-furnace; Brückner's Cylinders; a Metallurgical Laboratory; Sinking Shafts with the Diamond Drill, &c.

These reports have become an acknowledged authority on the subjects which they treat, and are remarkable for fairness and accuracy of statement. They have for years been quoted and discussed, and in a large part translated in Germany, where the general features of our western mining industry are almost as widely known as they are in this. Thence, many skilled metallurgists, mining mechanics, and men otherwise scientifically trained, have been drawn to this country as permanent residents, greatly to our advantage. B. S.

19. *The formation of Starch* in chlorophyll-grains (in the green parts of plants), under the action of light, was made out by Sachs ten or twelve years ago, and has been confirmed, and the conditions recently studied in various ways by Famintzin, Kraus, and Godlewski. It is maintained, if we rightly understand, that this starch is directly formed from carbonic acid under the action of light, i. e., is a primary product of assimilation. Böhm, of Vienna, who contested this, but whose view according to Sachs "has already been sufficiently refuted," has returned to the sub-

with new observations and experiments, now asserts, upon
ns stated, that
'he starch appearing in the seed-leaves of plantlets of Cress
ih and Flax, is not a direct assimilation-product, formed by
nmediate decomposition of carbonic acid, but a transforma-
roduct from a reserve of nutriment already present."
e would surely expect that the primary product of assimila-
f carbonic acid and water would be an organizable plasma
which the starch-grains in question are constituted, not an
iic structure such as a starch-grain is. It is not clear that
is much real difference between the two views, at least be-
i those of Sachs and Böhm. For since starch, as the former
ins, is formed and reformed in various parts of the plant and
from light and from chlorophyll, and in the leaf is allowed
only one of the products of assimilation, Sachs' assertion
tarch in chlorophyll-grains is "a product of assimilation,"
Böhm's that it is "not a direct assimilation-product," are by
eans in necessary contradiction. Nor is there apparent
n for supposing that a starch-grain in a potato-leaf is differ-
originated from one in a potato, except that the former is
ructed of new-formed material. A. G.

*A Report on the Trees and Shrubs growing naturally in
orests of Massachusetts;* by GEORGE B. EMERSON. Second
n. Boston: Little, Brown & Co., 1875. 2 vols. 8vo; with
plates.—The original edition, published in 1846, agreeably
order of the Legislature by the Commissioners of the
gical and Botanical Survey of the State, was a single vol-
of 534 pages, to which 17 outline plates were added, the
lrawing of the kind by Mr. Isaac Sprague. It was a classical
of so great use and value, that the edition (we believe a
one) was soon exhausted. Author and artist still flourish-
nd the zeal and public spirit of the former unabated, a new
n now appears, re-elaborated, enlarged, and amply illus-
l, forming two volumes, which reflect great credit upon
r, artists, and printer. There are 143 plates; and many of
from Mr. Sprague's drawings are colored chromoliths, more
ive and truthful than any which we remember to have seen
:. Several which exhibit the winter state of some of our
nous trees are full of character. The introduction of scenic
of many foreign, mainly European trees, copied from
is sources, adds a novel feature. Those who plant trees, and
any more who ought to be planting them, will value these
tive pictures the more, since they mainly represent well-
1 specimens of trees which are known or may by expected
rive in this part of the country. Some of them, from
er's Vegetable World, border a little on the sensational or
ous. The only one we are disposed to find much fault with
s in the place of honor, fronting the title-page, "*Sequoia
tea*, or Giant Pine of California." Why should it be called
e? Cypress would be nearer the mark if any of the old

common names need to be used. And why should the tree have a wall of the Yosemite Valley for a back-ground, since Mr. Emerson well knows that it does not grow there, however it may be with M. Figuier and his artist, Faguet. Through some oversight, in our copy, a plate, evidently representing the Black Oak, does supernumerary duty for Red Oak, which has two good plates of its own, one for the acorns and leaf, another for the port of the tree. There is a good figure of *Salix petiolaris*, but no letterpress. The severance of the long-standing connection between the Weeping Willow and Babylon, which has been referred to in this Journal, has escaped the venerable author's attention. We may be permitted to find some fault to relieve the monotone of praise which this attractive book calls forth. If space permitted we would call particular attention to the new part of the Preface, with its remark that, in the author's own experience upon our sea coast, European Oaks, Beech, Linden, Maple, Elm, Ash, Mountain-Ash, and Pine, are "more hardy than the corresponding American trees," and its warning close from Bryant's early poem, as well the important chapter on the uses, continuation and improvement of our forests. A. G.

21. *On the Classification and Sexual Reproduction of Thallophytes;* by W. T. Thiselton Dyer. An article of 33 pages 8vo, revised and reprinted from the Quarterly Journal of the Microscopical Society, London, July, 1875.—A timely and good *resumé* of all the important recent contributions to our knowledge of this subject, based upon the fourth edition of Sachs' *Lehrbuch*, with historical and critical discussion. The result is the provisional adoption of Sachs' classification, in which *Algæ*, *Fungi*, and *Lichens*, are relegated to the past, all Thallophytes are arranged in two parallel series, one with chlorophyll (*Algæ* and *Characeæ* of old) and one without, the latter being to the former nearly what *Monotropeæ*, *Orobancheæ*, *Cuscuta*, and the root-parasitic orchids are to the orders they respectively pertain to, or are parasitic representatives of; and the classes they are arranged under in a double series, viz: *Protophyta*, *Zygosporeæ*, *Oosporeæ*, and *Carposporeæ*, founded on characters of reproduction alone, and rising in increasing complexity and differentiation in the order indicated above. The green series begins below with the *Cyanophyceæ*, followed by the *Palmellaceæ*, and ends with *Florideæ* followed by *Characeæ*. The parallel *Fungi*-series begins with the *Schizomycetes* (Bacterians) followed by the *Saccharomycetes*, and these by the *Zygosporous Myxomycetes* and *Zygomycetes*, and ending with the *Ascomycetes*, under which are placed the *Lichens*, and finally the *Basidiomycetes*. This arrangement being "according to their morphological complexity," is thought to shadow forth, to a certain degree or with some probability, the "phylogeny" of the lower orders of the vegetable kingdom, although not with any strict genetic signification. As to this degradation of the *Lichenes*, it is remarked that the general result of the later investigations has been, on the whole, confir-

matory of Schwendener's view. A history of our knowledge of sexual reproduction in plants, and more particularly, of cryptogamous plants, occupies two or three of the earlier pages. To Thwaites is attributed the origination of the view that conjugation is sexual reproduction in its most generalized form. It seems strange that any different view could have been supported; but it is not so very long ago that it was maintained by Mohl. Thwaites and Jenner, as early as 1848, inferred "an apparent adumbration of the sexes" in *Zygnema*, &c., from the formation of the spore in the cells of one of the wholly similar parents, instead of between the two as in *Desmidieæ* and *Diatomaceæ*, but such adumbration is rather "apparent" than real. It was Thwaites who, in 1847, discovered conjugation in *Diatomaceæ*. Morren had long before discovered it in *Desmidieæ* (*Closterium*). The cilia of antherozoids were discovered in 1840, by Thuret, whose recent death, in the midst of important work, botanists may well deplore. In 1852 Thuret first obtained actual fertilization by the antherozoids in the case of *Fucus*. A. G.

22. *Monographie der Juncaceen vom Cap*, bearbeitet vom FRANS BUCHENAU. Bremen, 1875. 8vo.—This monograph of the *Juncaceæ* of the Cape of Good Hope, by Dr. Buchenau, is a separate issue from the *Abhandlungen des naturwissenschaftlichen Vereins zu Bremen*, Band iv, Heft 4, pp. 393–512, and is illustrated by 7 quarto plates, filled with details, devoted to the illustration of 32 species, chiefly of the genus *Juncus*. At the close is given a *resumé* of the literature of the South African *Juncaceæ*, from the Supplementum Plantarum of the younger Linnæus down to Steudel's Synopsis of *Glumaceæ*. Also names are given to the numbers in Drège's distributed collection. A. G.

23. *Elements of Zoology;* by SANBORN TENNEY. 8vo, 503 pp., with 750 wood-cuts. New York (Scribner, Armstrong & Co.) 1875.—In this work the author has attempted to give an outline of the Animal Kingdom by describing the larger groups, down to the orders and sub-orders. The principal characters of the classes are given with considerable fullness, in most cases, together with a summary of the orders or other subdivisions into which they are divided. and then each of the orders or sub-orders is briefly characterized and illustrated. The author has, in most cases, given under each class not only the classification that he adopts, but one or more of the different classifications that have been proposed by some of the leading writers on zoölogy. This feature will much increase the value of the work as a convenient book of reference, and will, perhaps, enable many teachers to use it as a text-book who may not wish to adopt the classification preferred by the author. The illustrations are very profuse and are, for the most part, well chosen and much superior in their execution to those ordinarily seen in similar text-books. This collection of figures would of itself render the work a very useful and valuable one for the use both of students and teachers. About five hundred of these cuts have been previously used in the

author's Manual of Zoölogy, and the two hundred and fifty additional ones have been selected from various other works. A list of the cuts is given, with the origin of each, which is a very commendable feature. The descriptions of the characters of the various groups are generally correct, though often rather too brief, and perhaps for this reason the statements are sometimes so general and indefinite as scarcely to be easily understood by beginners. It is natural, also, to expect positive errors in all works of this kind, for no one person can be familiar with the whole range of zoölogical science, as developed in recent times. We have noticed a few such errors in the work before us. Thus on pages 374 and 380 the well known Holothurian genus *Synapta* is included among the Gephyreans, an error so obvious that it would seem to have been accidental. A more serious error occurs on pages 216 and 227, where *Mosasaurus* and the allied genera are included among the Enaliosauria. On page 242 there is a confusion of ideas, although most of the facts are correctly stated, but the ordinary and normal larval state (Siredon-stage) of salamanders belonging to the genus *Amblystoma*, and many others, should not be confounded with the adults of genera like *Proteus* and *Menobranchus*. Yet, notwithstanding a few defects, we consider this the most useful manual of general systematic zoölogy that has hitherto been published in this country. V.

24. *First Book of Zoology;* by EDWARD S. MORSE. 12mo, 188 pp. 158 cuts. New York (D. Appleton & Co.) 1875.—In this little volume Prof. Morse has put, in a very simple and attractive form, a surprising amount of zoölogical instruction, such as beginners desire and need to have. The numerous figures are good and well chosen, and most of them are new and drawn from native animals by the author. They are mainly in outline and the author judiciously recommends learners to copy them in all cases, but if they should go farther and draw some of the real animals or their parts it would be still better. The book is devoted wholly to the Mollusca, Insects, Crustacea and Annelids, with a short but useful chapter on Vertebrates. The Protozoa, Radiata, Polyzoa, Brachiopoda, Tunicata, Cephalopoda, and most of the "Vermes" are not mentioned, the design being to describe those groups of animals that young students can most easily obtain for examination. Scientific names are wholly omitted, and although to many this may appear to be an advantage, we imagine that some indication of the name of each species figured, even in a list of figures at the end of the volume, would have considerably increased the value and usefulness of the book, both for pupils and teachers, for however little value we may attach to mere names, most persons, and especially young pupils, are generally anxious to know the names of animals that they may see, and read about, or at least to know whether they really *have* names, of which there is here no intimation, in most cases, and we fear that the majority of teachers and parents who may wish to use *this book* in teaching will hardly be able to give the missing

names of most of the figured species, which the author could so easily have supplied.

The style is clear and simple, and the descriptions are generally accurate, though brief. We have noticed but few errors worthy of note, and these will doubtless disappear in a second edition. In the figure of the mouth-parts of a craw-fish, on page 136, a superfluous appendage is given to the inner side of the mandible, and on page 147 the "*cervical suture*" of the carapax is erroneously said to represent "the dividing line between the head and thorax," which would be an absurdity, considering that the carapax is an outgrowth from the third and fourth (antennary and mandibular) cephalic segments. In the last part of the book the definitions of some of the classes and other groups are faulty, as for example, in case of Arachnida on page 185, where the definition would exclude a large proportion of the species belonging to it, as it really applies to but two of the four orders. The same may be said of the definition of "Vermes" both on pages 185 and 160. But there is much in the book that will be of interest and useful, even to advanced students. The chapter on the bones of the leg and wing of birds is particularly valuable. v.

25. *The Bones, Ligaments, and Muscles of the Domestic Cat;* by H. S. WILLIAMS. *With an atlas of photo-lithographic plates, reduced from those of Straus-Durckheim.* New York, (G. P. Putnam's Sons.) 1875.—The text of this work forms a small volume of 86 pages, devoted to the explanation of the accompanying plates. It is essentially a translation of the original explanations of Straus-Durckheim, with such revisions as the author has thought necessary, and with the substitution of Latin names of the parts for the original French terms. The plates have been well reduced by the Osborne photo-lithographic process to a small folio size, and correspond to the outline plates, 2 to 13, of the original work. The work is intended as a reference book for use in the practical study of comparative anatomy, and for this purpose will doubtless prove very useful, as it can be sold at a price that will bring it within the reach of all students, while the original work is costly and quite generally inaccessible in this country. We understand that Dr. Williams proposes to issue additional volumes with similar reductions of the plates illustrating the anatomy of the viscera and other organs. It is to be hoped that he may soon accomplish this, for in most cases it is quite as important, or even more so, that students should thoroughly study the digestive, circulatory, respiratory, and nervous systems, as the bones and muscles. v.

26. *Distribution of the Alcyonoid polyps of the Umbellularia group.*—The Umbellulariæ have been found

Off the coast of Greenland in 236, 410 and 121 fathoms.

In the *Atlantic* by the Challenger Expedition: (1) between Cape St. Vincent and Maderia, 35° 20′ N., 134½° W., in 2,125 fathoms; (2) 300 miles to the eastward of the St. Paul's rocks, 1° 47′ N., 24° 26′ W., in 1,850 fathoms; (3) off Brazil, 10° 11′ S., *35° 22′ W., in 1,600.*

In the Antarctic by the Challenger Expedition: (1) between Prince Edwards' and the Crozet Islands, 46° 46′ S., 45° 31′ E., in 1,375 fathoms; (2) 84 miles to the westward of Hog Island, one of the Crozets, 46° 16′ S., 48° 27′ E., in 1,600 fathoms; (3) near the ice barrier, 62° 26′ S., 95° 44′ E., in 1,975 fathoms; (4) north of the ice barrier, 53° 55′ S., 108° 35′ E., in 1,950 fathoms; (5) south of Australia, 42° 42′ S., 34° 10′ E., in 2,600 feet; (6) also in the Pacific, southwest of the Louisinde group, in 2,440 fathoms.

The Umbellulariæ are usually associated with such deep sea animals as *Ophiöglyphæ*, *Brisingæ*, *Pourtalesiæ*, *Ananchytids*, *Munopsids*, *Petalophthalmi*, *Gnathophausiæ*, *Macruri*, *etc.*—*R. V. Willemoes-Suhm in Ann. Mag. N. H.*, IV, v, 312.

III. Astronomy.

1. *Observations de Poulkova*; publiées par Otto Struve, Directeur de l'Observatoire Central Nicolas, volume vi. *Observations faites au Cercle Méridian*, St Petersbourg, 1873, folio, pp. v and 545. Among the most important astronomical publications of the past few years, must be enumerated the magnificent series of volumes published at Poulkova, one of the beautiful suburbs of St. Petersburg, by the Imperial Central Astronomical Observatory. The sixth volume of this series which contains the observations made from 1840 to 1855 by means of the Repsold meridian circle, has recently been received in this country. The number of observations contained in this single volume amount to 21,000, and appertain to the stars from the first to the sixth magnitudes, situated between the north pole and 15° of southern declination. The whole series of meridian circle observations will require still another volume, the seventh, and have been amassed through the labors of Sabler, 1840 to 1854, Döllen, 1844 to 1849, Lindhagan, 1854 to 1855, Winnecke, 1858 to 1864, and Gromadski, 1866 to 1869. Through the whole of this long period, no important changes have been made in the construction of the instrument, and but few changes in the methods of observation. The computations have been executed within the past few years under the successful direction of Wagner and Von Asten. C. A.

IV. Miscellaneous Scientific Intelligence.

1. *Journal of the Scottish Meteorological Society*, with Tables for year ending 31st December, 1874. Published quarterly. July, 1874—July, 1875. (William Blackwood & Sons, Edinburgh and London.)—This number of the Scottish Meteorological Journal contains, among its papers, a very important memoir on the influence of weather on mortality from different diseases and for different ages, by Mr. Alexander Buchan and Dr. Arthur Mitchell, extending to 80 pages. The enquiry embraces the three decades from 1845 to 1874 inclusive; and the Registrar-General's weekly reports of deaths in London are the basis of the

curves in the diagrams, the reports being full and the deaths all having taken place under one climate. To construct a curve for the deaths by any disease an average weekly death-rate of 20 is stated to be required. In connection with the tables of diagrams for each disease, there are meteorological reports for the same period.

It appears that in London the deaths from all causes for the 30 years, had their extreme maximum in December and January; that with the beginning of April there commenced a long decline in number to the extreme minimum in June; then began a rise to a second lower maximum in the latter half of July, continued through the first half of August; and then a decline to another minimum in October, after which the rise toward the December maximum began.

The following are some of the facts indicated with regard to deaths in London: The death-rate for scarlatina is low for March, April, May, and high for October and November; for whooping cough, high from February, March to April, and low for September and October; for typhoid fever, low for May, June and early July, and high for November and late October; for dysentery and diarrhœa, low for January and June, and very high in the latter half of July and August; for bronchitis, pneumonia and asthma, high in December, January and February, with the extreme in January, and low from June to October; by suicide, maximum from April to the last of June, and an extreme minimum in the early part of February. These cases and those of all other diseases of which the deaths were sufficiently numerous are exhibited in the diagrams.

The paper next takes up the question of deaths and their diseases during six sections of the year distinguished by differences in temperature and dryness; then the influence of weather on deaths at different ages, showing one maximum for children under one year in the latter half of July and beginning of August, and another higher in December, January and February, while for individuals above one year only the latter maximum is distinct. Afterward the influence of weather on the mortality of the two sexes is illustrated, bringing out a maximum for both in December, January, and the latter part of March, a minimum for both in June, a second maximum in the latter half of July and first half of August, and a second minimum in October, with the winter maximum higher, and the summer minimum lower, for females than for males. Another table shows that, deducting the deaths from bowel complaints, there is no summer maximum for deaths by all other diseases, but instead a continued minimum which is greatest in July and August. The diseases which are like bowel complaints in having their maximum in summer, are shown to be jaundice, tabes mesenterica, enterites, thrush, atrophy and debility. The article closes with four long tables; Table I, showing the different diseases for each year, together with a column stating the population of London; Table II, giving the mean weekly death rate

on an average of the 30 years for each of the different causes of death; Table III, showing for the different diseases and other registered causes of death for the 30 years the *percentages* of *excess* or *defect* of the death-rate of each week of the year as compared with the general average of the 52 weeks; and Table IV, showing the average death-rate *at different ages* from all causes.

2. *Voyages a la Cote Nord-Ouest de l'Amérique exécuté durant les Années*, 1870–72; par ALPH. L. PINART. Vol. I, Partie I, Histoire Naturelle. Paris, 1875. 4°, pp. 51, with plates A to E.—Mr. Pinart has devoted himself to the self-imposed task of exploring the Northwest Coast of America, with special reference to the ethnography of the tribes inhabiting Alaska and the Aleutian Islands. The author, being himself especially devoted to ethnographical and linguistic studies, has sought, in this part of his beautiful work, the aid of men eminent in their own departments in working up the natural history materials collected by him. M. Jannettaz, President of the Geological Society of France, has prepared the catalogue of geological specimens and observations on them; M. Léon de Cessac has made the Microscopical and Chemical analyses of some of the rocks of Alaska; the Paleontology is prepared by M.M. Gaudry and P. Fischer; and the Zoology is by Fischer, E. Perrier and P. Gervais. The author proposes to issue three volumes of this series, each to contain six parts similar to the one now issued. He has favored us with a sight of the plates illustrating the ethnology of his voyage, which he has enriched by researches during three winters in St. Petersburgh, where the extended collection made by the missionaries of the Greek Church, during a century or more, were liberally placed at his disposal by the Russian Government. Having completed the manuscript, and left the execution of the work to his publisher, he is again about entering on a new exploration, under a commission from the French Government, having for its object the study of the ethnology and languages of the southern races of the west coast of both North and South America. After visiting Washington he plans to go to San Francisco and thence by the coast to Valparaiso, with a view of determining if possible, besides other things, the source and direction of migration of the native American tribes of both hemispheres. Fortunately for science, M. Pinart is willing to devote his time and ample private fortune to these researches. His Government has encouraged him by giving him a commission which requires him to report specially upon certain points with reference to the Central American States, with which his former voyages have already made him familiar. B. S.

3. *General Index of Professional and Scientific papers contained in the United States Coast Survey Reports from* 1851 *to* 1870. Constituting Appendix 17 in the Report for 1871.—The Coast Survey Reports issued under the late eminent Superintendent, Prof. Bache, and also his able successor, Prof. Peirce, contain a large number of original memoirs of high scientific character,

and consequently this Index has great importance. The volumes contain many papers discussing tides in general, and the tides of the Atlantic, Pacific, and of special portions of the coast of the United States by Professor Bache; also others on tides, by C. A. Schott, G. Wurdemann, &c.; several papers on the Gulf Stream, its depth, temperature and soundings, by Prof. Bache, with others by E. B. Hunt, H. Mitchell, &c.; papers on hydrographic changes produced by tides and currents; on the measurements of heights, by T. J. Cram; on the chronometric determinations of longitude, by W. C. and G. P. Bond, A. D. Bache, C. A. Schott; on telegraphic determinations of longitude, by S. C. Walker, B. A. Gould, G. W. Dean, &c.; on longitude by occultations of the Pleiades, and lunar tables used in the same, etc., by Prof. Peirce; on the observations of the solar eclipse of July, 1851, with reference to longitude determinations, by Prof. Peirce; use of zenith-telescope for observations of time, by J. E. Hilgard; on star-catalogues, by C. A. Schott; on solar eclipses, by various authors; on solar spots, by C. A. Schott; on the moon's mass, as deduced from a discussion of the tides of Boston harbor, by William Ferrel; on deep sea soundings, by W. P. Trowbridge; on terrestrial magnetism, giving observations in the United States and general discussions, by Prof. Bache (and including his memoir on his magnetic survey of Pennsylvania and the adjoining States in 1834 to 1862), Mr. Schott (whose papers are very numerous), W. P. Trowbridge, J. E. Hilgard, G. W. Dean; on deep sea dredgings, by J. W. Bailey, L. F. Pourtalés, Prof. Agassiz; on the Florida coral reef, by Prof. Agassiz, also by E. B. Hunt; on earthquake waves in the Pacific, by A. D. Bache, also by J. E. Hilgard; besides a large number of papers bearing on other topics arising out of the survey. The papers on physical subjects are among the most important that have been anywhere published.

4. *On a Discovery of Meteoric Iron in Missouri*; by G. C. BROADHEAD (Mines, Metals and Arts, St. Louis, for Sept. 20).—Nearly six months ago I obtained knowledge of a mass of meteoric iron in Bates County, but only recently found out just where it was, and last week I went to Butler and obtained it. It was plowed up in a field by a man named Abram Crabbe, living eight miles southwest of Butler. For a long time it remained scarcely noticed by him, but at last, thinking it rather heavy, he brought it into Butler and left it at a blacksmith's. When I heard of its being there, I requested a fragment. A piece was cut off; the smith, first heating it, was occupied nearly two hours in the cutting.

This is the first meteorite that we know of having been found in Missouri. Its total weight is a little less than 90 pounds, and it is a rough-looking, rather irregular mass, somewhat pitted over the surface, as they generally are. From its great weight in comparison with its size and luster, I suppose it to be nearly all native iron with undoubtedly some nickel in its composition.

Pleasant Hill, Mo., September 1.

5. *On Poisons in relation to Medical Jurisprudence and Medicine.* By ALFRED SWAINE TAYLOR, M.D., F.R.S., &c. Third American, from the third English edition. Philadelphia, H. C. Lea. 1875. 8vo, pp. 788, with 104 illustrations in the text— Dr. TAYLOR's manual on poisons long ago became a standard authority, and the appearance of a new and thoroughly revised edition brought down to May, 1875, will be welcomed by all interested in such studies. A rapid survey of the volume shows extensive changes, both by addition and omission. In fact the work has been remodelled in accordance with the changes of toxicological science, to meet the wants of students in law and medicine. B. S.

6. *On the Strength of the Lion and the Tiger*; by Rev. SAMUEL HAUGHTON.—In Nature, vol. xii, p. 474, in a review of Dr. Fayer's book on the tiger, doubts are thrown by the reviewer on the statement that the tiger is stronger than the lion. Dr. Fayer's statement cannot be contradicted by any person well acquainted with both animals. In my book on "Animal Mechanics," published in 1873, I have proved, p. 392, that the strength of the lion in the fore limbs is only 69·9 per cent of that of the tiger, and that the strength of his hind limbs is only 65·9 per cent of that of the tiger.

I may add that five men can easily hold down a lion, while it requires nine men to control a tiger. Martial also states that the tigers always killed the lions in the amphitheatre. The lion is, in truth, a pretentious humbug, and owes his reputation to his imposing mane, and he will run away like a whipped cur, under circumstances in which the tiger will boldly attack and kill.—*Nature, Oct. 7, in a letter dated Trinity College, Dublin, Oct.* 1.

OBITUARY.

WILLIAM JORY HENWOOD, F.R.S., F.G.S., died on the 5th of August, in his 71st year. He was the author of papers on Mineralogy, and of elaborate memoirs on the metalliferous deposits of Cornwall and Devon, and various other topics connected with mines and mining.

SAMUEL D. TILLMAN, Ph.D., LL.D., died September 4th, at the age of 62 years. Prof. Tillman's contributions to chemical literature have been mainly in the departments of chemical philosophy and nomenclature.

Unsere Korperform und das Physiologische Problem ihrer Entstehung. Briefe an einen befreundeten Naturforscher von WILHELM HIS. Mit 104 Holzschnitten Leipzig, Verlag von F. C. Vogel. 1875. 8vo, pp. 224.

Cholera Epidemics of 1873 in the United States. 1026 pp. 8vo. Washington. 1875. 43d Congress, 2d session, House of Representatives. Ex. Doc. No. 95. Besides the long detailed Report on the Cholera epidemic of 1873 in North America by John M. Woodworth, M.D., this volume contains a report by Ely McClellan, M.D. on that of 1832, 1833, 1834, of 1848, of 1854, and of 1865, 1866, in North America; and also a history of the travels of Asiatic Cholera in Asia and Europe, by John C. Peters, M.D. The volume is illustrated by maps, and closes with a very extended bibliography.

APPENDIX.

Art. LI.—*On the Odontornithes, or Birds with Teeth;* by Prof. O. C. Marsh. With plates IX and X.

Remains of birds are among the rarest of fossils, and few have been described except from the more recent formations. With the exception of *Archæopteryx* from the Jurassic, and a single species from the Cretaceous, no birds are known in the old world below the Tertiary. In this country, numerous remains of birds have been found in the Cretaceous, but there is no satisfactory evidence of their existence in any older formation, the three-toed footprints of the Triassic being probably all made by Dinosaurian reptiles.

The Museum of Yale College contains a large series of remains of birds from the Cretaceous deposits of the Atlantic coast and the Rocky Mountain region, thirteen species of which have already been described by the writer. The most important of these remains, so far as now known, are the *Odontornithes*, or birds with teeth, and it is the object of the present communication to give some of the more marked characters of this group, reserving the full description for a memoir now in course of preparation.

The first species of birds in which teeth were detected was *Ichthyornis dispar* Marsh, described in 1872.* Fortunately the type specimen of this remarkable species was in excellent preservation, and the more important portions of both the skull and skeleton were secured. These remains indicate an aquatic bird, fully adult, and about as large as a pigeon.

The skull is of moderate size, and the eyes were placed well forward. The lower jaws are long, rather slender, and the rami were not coössified at the symphysis. In each lower jaw there are twenty-one distinct sockets, and the series extends over the entire upper margin of the dentary bone, (Plate IX, figures 1 and 2). The teeth in these sockets are small, compressed and pointed, and all are directed more or less backward. The crowns are covered with nearly smooth enamel. The maxillary teeth appear to have been numerous, and essentially the same as those in the mandible. Whether the premaxillary bones supported teeth, or were covered with a horny beak cannot be determined from the present specimen.

* This Journal, vol. iv, p. 344, and vol. v, p. 74.

The scapular arch and the bones of the wings and legs all conform closely to the true avian type. The sternum has a prominent keel, and elongated grooves for the expanded coracoids. The wings were very large in proportion to the legs, and the humerus had an extended radial crest. The metacarpals are coössified, as in recent birds, thus differing widely from those of *Archæopteryx*. The bones of the posterior extremities are slender, and resemble those of some aquatic birds. The centra of the vertebræ are all biconcave, the concavities at each end being distinct, and nearly equal. (Plate IX, figures 3 and 4.) The sacrum is elongated, and made up of a large number of coössified vertebræ. Whether the tail was elongated or not cannot at present be decided.

The jaws and teeth of this species show it to have been carnivorous, and it was probably aquatic. Its powerful wings indicate that it was capable of prolonged flight.

Another Cretaceous bird, (*Apatornis celer* Marsh,) belonging apparently to the same order as *Ichthyornis*, was found by the writer in 1872 in the same geological horizon in Kansas.* The remains preserved indicate an individual about the same size as *Ichthyornis dispar*, but of more slender proportions. The vertebræ are biconcave, and there were probably teeth.

The most interesting bird with teeth yet discovered is perhaps *Hesperornis regalis*, a gigantic diver, also from the Cretaceous of Kansas, and discovered by the writer in 1870. The type specimen which was found by the writer in 1871, and described soon after, consisted mainly of vertebræ and the nearly complete posterior limbs, all in excellent preservation.†

A nearly perfect skeleton of this species was obtained in Western Kansas by Mr. T. H. Russell and the writer in November, 1872, during the explorations of the Yale College party, and several other less perfect specimens have since been secured, and are now in the Yale Museum. These various remains apparently all belong to one species.

The skull of *Hesperornis* has the same general form as that in *Colymbus torquatus* Brün., but there is a more prominent median crest between the orbits, and the beak is less pointed. The brain cavity was quite small. The maxillary bones are massive, and have throughout their length a deep inferior groove which was thickly set with sharp, pointed teeth. These teeth had no true sockets, but between their bases there are slight projections from the sides of the grooves. (Plate X, figure 2.) The teeth have pointed crowns, covered with enamel, and supported on stout fangs (Plate X, figure 1a.) In form of crown and base, they most resemble the teeth of Mosasauroid reptiles. The method of replacement, also, was

* This Journal, v, 74, Jan., 1873. † This Journal, iii, 360, May, 1872.

ıe same, as some of the teeth preserved have the crowns of ıe successional teeth implanted in cavities in their fangs. 'he maxillary grooves do not extend into the premaxillaries, nd the latter do not appear to have supported teeth. The xternal appearance, moreover, of the premaxillaries seems to ıdicate that these bones were covered with a horny bill, as in ıodern birds.

The lower jaws are long, and slender, and the rami were nited in front only by cartilage. The dentary bone has a deep roove throughout its entire length, and in this, teeth were thick- ƴ planted, as in the jaws of *Ichthyosaurus.* The lower teeth re similar to those above, and all were more or less recurved. Plate X, figure 1.) These grooves contain slight projections ·om the sides, but there are no true sockets. (Plate X, figure 2.)

The scapular arch of *Hesperornis* presents many features of ıterest. The sternum is thin and weak, and *entirely without a eel.* In front, it resembles the the sternum of *Apteryx*, but there re two very deep posterior emarginations, as in the Penguins. 'he scapula and coracoid are very small. The wing bones are iminutive, and the wings were rudimentary, and useless as rgans of either flight or swimming.

The vertebræ in the cervical and dorsal regions are of the true ·rnithic type, the articular faces of the centra being quite as in nodern birds. (Plate X, figures 3 and 4.) The sacrum is elon- ;ated, and resembles that in recent diving birds The last acral vertebra is quite small. The caudal vertebræ, which are ıbout twelve in number, are very peculiar, and indicate a struc- ure not before seen in birds. The anterior caudals are short, vith high neural spines and moderate tranverse processes. The niddle and posterior caudals have very long and horizontally ·xpanded tranverse processes, which restrict lateral motion, but ·learly indicate that the tail was moved vertically, probably n diving. The last three or four caudal vertebræ are firmly ·oössified, forming a flat terminal mass, analogous to, but quite ınlike, the "ploughshare" bone of modern birds. The ınterior two at least of these caudals have expanded transverse processes.

The pelvic bones, although avian in type, are peculiar, and present some well marked reptilian features. A resemblance o the corresponding bones of the Cassowary is at once evident, specially in a side view, as the ilium, ischium, and pubis all ıave their posterior extremities separate. The two latter are lender, and also free back of their union with the ilium at the ıcetabulum. The ischium is spatulate at its distal end, and the ubis rodlike. The acetabulum differs from that in all known irds, in being closed internally by bone. except a foramen hat perforates the *inner wall.*

The femur is unusually short and stout, much flattened antero-posteriorly, and the shaft curved forward. It somewhat resembles in form the femur of *Colymbus torquatus* Brün., but the great trochanter is proportionally much less developed in a fore-and-aft direction, and the shaft is much more flattened. The tibia is straight and elongated. Its proximal end has a moderately developed cnemial process, with an obtuse apex. The epi-cnemial ridge is prominent, and continued distally about one-half the length of the shaft. The distal end of the tibia has on its anterior face no ossified supratendinal bridge, differing in this respect from nearly all known aquatic birds. The fibula is well developed, and resembles that of the Divers. The patella is large, as in *Podiceps*, and in position extends far above the elevated rotular process of the tibia.

The tarso-metatarsal bone is much compressed transversely, and resembles in its main features that of *Colymbus*. On its anterior face there is a deep groove between the third and fourth metatarsal elements, bounded on its outer margin by a prominent rounded ridge, which expands distally into the free articular end of the fourth metatarsal. This extremity projects far beyond the other two, and is double the size of either, thus showing a marked difference from any known recent or fossil bird. There is a shallow groove, also, between the second and third metatarsals. The second metatarsal is much shorter than the third or fourth, and its trochlear end resembles in shape and size that of the former. The existence of a hallux is indicated by an elongated oval indentation on the inner margin above the articular face of the second metatarsal. The free extremities of the metatarsals have the same oblique arrangement as in the *Colymbidæ*, to facilitate the forward stroke of the foot through the water. There are no canals or even grooves for tendons on the posterior face of the proximal end, as in the Divers and most other birds; but below this, there is broad, shallow depression, extending rather more than half way to the distal extremity.

The phalanges are shorter than in most swimming birds. Those of the large, external toe are very peculiar, although an approach to the same structure is seen in the genus *Podiceps*. On the outer, inferior margin, they are all deeply excavated. The first, second, and third have, at their distal ends, a single, oblique, articular face on the inner half of the extremity, and the outer portion is produced into an elongated, obtuse process, which fits into a corresponding cavity in the adjoining phalanx. This peculiar articulation prevents flexion except in one direction, and greatly increases the strength of the joints. The terminal phalanx of this toe was much compressed. The third, or middle, toe was greatly inferior to the fourth in size, and had

er, compressed phalanges, which correspond essentially in main features with those of modern Divers.

e remains preserved of *Hesperornis regalis* show that this es was larger than any known aquatic bird. All the mens discovered are in the Yale College Museum, and essentially in size, the length from the apex of the bill to nd of the toes being between five and six feet. The hab- f this gigantic bird are clearly indicated in the skeleton, st every part of which has now been found. The rudi- ary wings prove that flight was impossible, while the rful swimming legs and feet were peculiarly adapted to motion through the water. The tail appears to have been i expanded horizontally, as in the Beaver, and doubtless in efficient aid in diving, perhaps compensating in part for of wings, which the Penguins use with so much effect in ming under water. That *Hesperornis* was carnivorous is ly proven by its teeth; and its food was probably fishes.

e zoological position of *Hesperornis* is evidently in the *tornithes;* but the insertion of the teeth in grooves, the ice of a keel on the sternum, and the wide difference in ertebræ require that it be placed in a distinct order, which be called *Odontolcæ*, in allusion to the position of the teeth ooves.

e two orders of birds with teeth would then be distin- ied as follows:—

Sub-Class, ODONTORNITHES (or AVES DENTATÆ).

eeth in sockets. Vertebræ biconcave. Sternum with keel. Wings well developed.

Order, ICHTHYORNITHES.

eeth in grooves. Vertebræ as in recent birds. Sternum without keel. Wings rudimentary.

Order, ODONTOLCÆ.

comparing *Ichthyornis* and *Hesperornis*, it will be noticed the combination of characters in each is very remarkable, quite the reverse of what would naturally be expected. former has teeth in distinct sockets, with biconcave verte- while the latter has teeth in grooves, and yet vertebræ ar to those of modern birds. In point of size, and means omotion, the two present the most marked contrast. The hat two birds, so entirely different, living together during Cretaceous, should have been recovered in such perfect rvation, suggests what we may yet hope to learn of life in period.

The geological horizon of all the *Odontornithes* now known is the Upper Cretaceous. The associated vertebrate fossils are mainly Mosasauroid reptiles and Pterodactyls.

A full description with plates of all the known *Odontornithes* is now being prepared by the writer.

Yale College, New Haven, Oct. 18th, 1875.

EXPLANATION OF PLATES.

Plate IX.—*Ichthyornis dispar* Marsh. Twice natural size.

Figure 1. Left lower jaw; side view.
Figure 2. Left lower jaw; top view.
Figure 3. Cervical vertebra; side view.
Figure 4. Same vertebra; front view.

Plate X.—*Hesperornis regalis* Marsh.

Figure 1. Left lower jaw; side view; half natural size.
Figure 1*a*. Tooth; four times natural size.
Figure 2. Left lower jaw; top view; half natural size.
Figure 3. Dorsal vertebra; side view; natural size.
Figure 4. Same vertebra; front view.

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[THIRD SERIES.]

ART. LII.—*On Southern New England during the melting of the Great Glacier*; by JAMES D. DANA. No. IV.*

IV. DEPRESSION OF THE LAND, OR AMOUNT OF SUBSEQUENT ELEVATION.

THE higher of the terraces of stratified drift, especially of those along the shores of estuaries and tidal inlets, or within the lower tidal part of the river valleys, are rightly regarded as evidence, *after making the necessary deductions*, of the amount of upward change of level which the region containing them has undergone. The following are some heights above high-water or flood level observed in Southern New England:

1. The terrace plain, or upper level of the stratified drift, in the northeast corner of the New Haven plain, near Whitneyville—50 feet; and in the northwest corner, at Westville—47 feet.

2. On the Housatonic River near Birmingham, ten miles from the Sound and nine miles west of New Haven—95 feet.

3. In the Connecticut valley, in the vicinity of Middletown, about thirty miles from the Sound and twenty-three miles northeast of New Haven—150 feet.

4. At the head of the fiord called the River Thames, at Norwich, sixteen miles from the Sound and nearly fifty miles north of east of New Haven—110 feet.

5. At the head of Narragansett Bay, about Providence, a mile above the mouth of Providence River, and about 100 miles north of east of New Haven—80 feet.

Here we have terraces at five places in Southern New England, thirty miles or less from the Sound, and within reach of

* For the preceding parts of this memoir see pp. 168, 280, 353, of this volume.

the tides, having the following heights above flood-level: near New Haven, 47 to 50 feet; at Birmingham, 95 feet; near Middletown, 150 feet; at Norwich, 110 feet; and at Providence, 80 feet. What are *the necessary deductions* to be made from these numbers in order to obtain for each place the amount of that change of level (the depression of the land when the deposits were made, and the subsequent elevation) which led to the present elevated position of these plains of stratified drift, making them into river-valley and estuary terraces? If any elevated shell-bearing sea-beaches existed on the shores of the Sound, the question as to the amount of elevation since the Champlain period would be easily answered. But such evidence as already explained, is wanting; and wanting also outside of the limits of the Sound, even to Cape Cod.

In order to make correct observations on this subject and arrive at right conclusions, several points have to be noted, a brief review of which is here given by way of introduction.

1. The height to be measured should be that of the highest terrace plain above the level of the highest modern flood-plain or lower flats. For the terrace-plain, where of full height, marks approximately the flood-level of the Champlain era, just as the flood-plain of a stream in these modern times marks the level nearly of modern floods. This point has been considered in obtaining the numbers for the heights above given, each being the height of the terrace-plain above flood-water level.

2. An allowance has to be made for the excess in height of the Glacial flood that attending the melting over the height of modern floods. If modern floods raise a stream 20 feet above low water mark, and hence make a flood-plain at that height, and a Glacial flood were so great as to produce a rise of 50 feet above the same low water line, the flood-plain made from the depositions of such a Glacial flood, if at the water level, would be 30 feet higher than that from ordinary floods, and when the flood subsided, the flood-plain so made would exist as an elevated terrace, 30 feet above the lower flats, although there had been no change of level whatever. The terrace here is evidence of the height of the flood, and not of any change of level in the land. Moreover, supposing in addition an elevation to have taken place, 30 feet of the height of the Glacial flood-plain, if of the full normal height, would have to be credited to the excess in height of the Glacial flood.

Moreover, the deposits of those thirty feet may all have been made in *shallow* water, that is, each near flood-level, as the flood rose in height; so that the marks of shallow water origin in the lower and overlying beds would not in this case be proof of a gradual subsidence as the deposition went forward.

3. A further allowance has often to be made on account of

local obstacles to the free discharge of the waters, giving a local height to the flood, much exceeding that usual along the valley. When a river valley is suddenly contracted, or when large tributaries join it at a given point, the stream may be carried in such places to an abnormal height—and so produce deposits up to that abnormal level—because the water cannot escape as fast as it is supplied. Moreover, for the same reason, the depth of water in the receiving estuary, and in the Sound just off the mouth of the stream, are elements to be considered; since, if very shallow, the water, under a flood of supposable magnitude, might be raised in an estuary several yards above the true tide-level; and a few feet perhaps over shoals off its mouth in the Sound, notwithstanding the wide spreading of the water on either side.

4. To guard against error, the true limit between the *stratified* drift of a valley or estuary and the *unstratified* of the adjoining hills must be carefully determined, for only the former is the terrace or flood-made formation. To be sure of correctness on this point, it has to be considered that the *unstratified* drift has sometimes locally a degree of stratification of a tumultuous kind, due to the rush of waters from the melting glacier; and, again, the *stratified* drift may fail of distinct bedding. Hence in all cases a wide range of level terrace-plain—so wide that there can be no reasonable doubt that it was levelled under water, should be sought for, in order thereby to confirm the evidence from other sources as to the deposits being of under-water origin.

An important mark of such river-valley, estuary or sea-border formations consists in the total or nearly total absence of great bowlders from their level surface. The slopes of the hills above carry bowlders usually down to the level of the plain; then they cease suddenly, scarcely one existing over the plain that tops the water-made deposits. This may be observed along all the river valleys of New England, and also in many places on its shores. Between Watch Hill and Point Judith, the hills are thickly strewn with the huge blocks, down to within eleven feet of high water level; there, along a large part of that coast, wide meadows are spread out without a bowlder. But wherever the surface over the meadows swells upward above the eleven-foot level, it is peppered as thickly with bowlders as the slopes of the neighboring hills. Some bowlder-areas occur that are scarcely above it because the surface there was at the water's level when the bowlders were dropped. The ice, as melting went forward, let go first the great rocks that were in its bottom or lower part, and where there was water underneath instead of land they sunk and were spread, along with much coarse gravel, over the bottom, there to be buried beneath later depositions. The material of these later beds along the river

valleys was brought down and deposited by the flooded river as the melting went forward and the glacier retreated; or they were carried into the valley from the hills either side of the valley—all the slopes under the deluge of waters sending down earth and stones, as well as the ravines and side-valleys, to be stratified and levelled off by the rushing stream.

It is not safe to infer that all New England hills with grassy bowlderless surfaces are parts of a valley terrace; for some regions afforded few bowlders to the ice; or only soft easily decomposable material; but when the hills rise to a common height and have a flat top, there can be little reason for doubt.

5. It is further to be noted that the terrace or terraces of a region may be only one or more of the *lower* terraces instead of the highest; that is, in other words, the *highest* normal to the region may be wanting, either (1) because there the flood-waters made no depositions up to flood-level, owing to its fierce rate of flow, or some other cause, but built up only to lower levels; or (2) because the highest part of the formation, after its deposition, was swept off and so reduced to a lower level by the flood when in its period of greatest violence, leaving only a lower terrace in its place, with perhaps traces of the higher, or often, not even these.

6. A careful study of the kind of *stratification* in the deposits is needed in order to determine whether the beds were deposited (1) under the action of the *incoming tide* on the sands and gravel from the dissolving glacier or drift-covered hills; or (2) under the action of the *outflowing river*. This study requires that the cuttings for all road-gradings, wells, sewers, and cellars, in the stratified drift of an estuary, should be carefully examined. When the facts as to structure are fully understood, the question whether *sea-made* or *river-made* may in this way receive a positive answer even along shores having no [redacted]

servations needed to settle all doubtful points demand long-continued investigation in each estuary region of the coast, such a study as can be satisfactorily carried forward only by one who is living in the region and is thus always at hand to take advantage of every excavation that may be made in the deposits for cellars or other purposes. And to this should be added an accurate topographical and hydrographic survey of the estuary regions, and of the river valleys within thirty miles of the coast.

After these preliminary considerations I proceed to the discussion of the facts bearing on the level of Southern New England in the Champlain period, or, its equivalent, the amount of elevation which may be proved, from existing conditions, to have taken place since that period.

I. New Haven Region.

The evidence with regard to the amount of depression over the New Haven region which has been obtained is from the following sources :

1. From the height of the upper or highest terrace of a region above mean high tide.
2. From the depth of the valley-excavations along the rivers and estuaries, or the height of the upper terrace above the flood-plain of the present streams.
3. From the structure of the beds.
4. From the existence of "Alluvian" deposits.

1. *Height of the terrace-plain or stratified-drift formations above mean high tide.*—This terrace-plain in the New Haven region is the wide plain upon which the city is built. (The map of the region is here reproduced, in order that the relations of the localities referred to beyond may be appreciated). It extends *southward*, by the west side of the New Haven Bay, through West Haven to the Sound east of Savin Rock—a rocky point terminating the first range of hills on the west. It is also continued northward through Hamden to Mount Carmel; but it gradually diminishes in width in this direction and at last is confined to the vicinity of Mill River. The distance from Savin Rock to Mount Carmel in an air-line is eleven and a half miles, and it is one sloping plain. From the upper part of the city (about four miles north of Savin Rock), where the land is 45 to 47 feet above mean high tide, there is a gradual slope seaward (that is, southward), toward the West Haven coast, of 10 to 11 feet a mile; and there is also the same gradual rise northward toward Mount Carmel. No trace of any beach-like break is to be found across the surface; no line of sand hills or ridges; nothing whatever to make one part more than another to look like the course of a beach or water-line.

This is well seen, for the lower part of the plain, when standing on a bridge in the West River valley: an unbroken terrace makes the sides of the river valley from Westville, where the height is 47 feet above mean high tide, to the mouth of the stream, where, opposite Oyster Point, it is 20 feet; and going on toward the West Haven beach, the plain continues its slope, terminating with a height of 5 feet at the beach, or 8 feet just back near the western hills. And for the middle and upper part of the plain it is apparent along the road (Dixwell avenue) passing over the great plain from New Haven northward into Hamden, where the surface over a very wide area is all open to view so that any abrupt change of level or variation in the surface would be easily detected if such existed. There are hence on the surface of the plain no marks of a shore-line of the Champlain period.

Again, no sea-shore or beach deposit is found anywhere about the lower slopes of the hills above the level of the plain. The passage is every where abrupt from the even plain to the rising hill-side, that is, from the terrace of stratified drift to the unstratified drift of higher levels, and this is true quite to Savin Rock on the Sound. On the east side of this bay the same is true; but the terrace on that side is mostly wanting, and the cape is rocky, so that the fact is less significant.

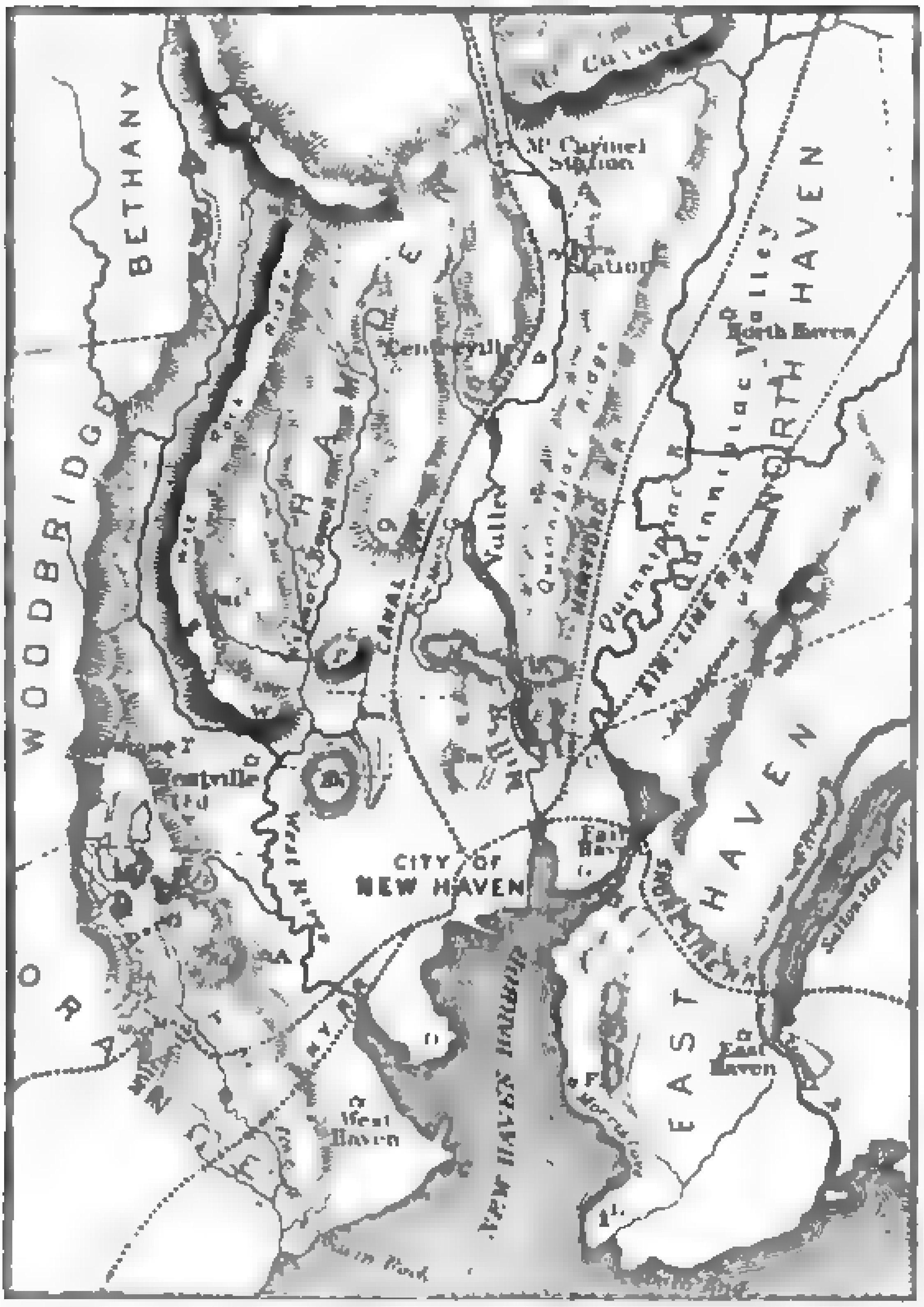
The following are the elevations of the plain at different points between the Sound and Mt. Carmel village.

				Feet.
Near Savin Rock beach, on the Sound,				5
0·5 mile north of Sound, highest near foot of hills,				10–14
1·5 miles	"	"	S.W. of bridge over West R.,	18
2 "	"	"	c. Kimberly and Greenwich sts.,	23
2·5 "	"	"	on Putnam st.,	31
2·9 "	"	"	c. of Congress av. and Cedar st.,	35
3·5 "	"	"	c. of Elm and York sts.,	42
4 "	"	"	c. of Dixwell av. and Henry st.,	49
4·5 "	"	"	c. of Dixwell av and Division st.,	52
5·3 "	"	"	c. of Dixwell av. and Dudley st.,	61
6 "	"	"	Dixwell, near house of H. Munson,	68
6·5 "	"	"	Hamden church on Dixwell av.,	76
7·25 "	"	"	Dixwell av., near J. E. Bassett's,	82
9·5 "	"	"	N. Centreville, at meeting of roads,	103
11·5 "	"	"	near Mt. Carmel village,	115

An even slope is not to be expected since (1) the shore flats or flood-grounds of a river or lake are never even; and because (2) terraces have often lost much of their height by denudation, or gained or lost in height through drifting sands.*

* I am indebted to Mr C. E. Fowler, New Haven City Surveyor, for the heights of the various parts of the plain along the streets within the limits of the city, and to levelings by Mr G. B. Chittenden and D. H. Pierpont, carried on under the direction of Mr. R. M. Bache of the Coast Survey, for heights through Hamden to Mt. Carmel.

MAP OF THE NEW HAVEN REGION.



Explanations of the map. A, Allingtown village. B, Beacon Hill. Bh, Beaver Hills. Ch, Cherry Hill. C, Air Line Railroad cut near south end of East Rock. E, East Rock range, consisting of East Rock proper to the northwest, Indian Head, and then Snake Rock. Ed, Edgewood, the estate of Donald G. Mitchell, Esq. F, Fort Hale. K, Ferry Point or Red Rock, on the Quinnipiac. J, Judges Cave, on the West Rock ridge. L, Light House. M, Mill Rock. M P, Maltby Park, only three of the proposed lakes of which are constructed. O, Oyster Point. P, Pine Rock. R1, Round Hill. Rt, Rabbit or Peter's Rock. Sm, Sachem's ridge. T, Turnpike. Tb, Tomlinson's bridge across the head of New Haven bay. V, Whitneyville. W, West Rock, the south end of the West Rock ridge. W C, West Cape or West Haven Point. Wh, Whitney Peak. W L, Wintergreen Lake, just north of Wintergreen Falls. Wn, Warner's Rock. bm, Beaver Pond Meadows. m, Mineral spring southeast of North Haven; n1, n2, n3, n4, different notches in the West Rock ridge; n1, n2, the upper and lower Bethany Notches; n3, the Hamden Notch; n4, the Wintergreen Notch.

Scale 4-10ths of an inch to the mile.

The part of the plain stretching northward through Hamden to Mount Carmel village, reaching there a height of about 115 feet above the sea, owes its slope to the pitch of the flooded stream, which there flowed over a sandstone region with no deep channel to confine its waters and direct their course. That it was not due to marine submergence to a depth of 115 feet is proved by the facts in the adjoining Quinnipiac valley, a mile and a half to the eastward. For at North Haven, six miles north of New Haven, the stratified drift or terrace has a height above flood level not exceeding 45 feet; and this is but two feet above its level five miles to the south, just north of west of New Haven city; facts which show that there was a nearly level surface over the great Quinnipiac basin or harbor between these distant points, and that the greatest height of the marine submergence, if there was one, could not have exceeded 45 feet.

If then the upper part of the sloping plain from Mount Carmel southward was made by fresh waters from the melting glacier, shall we conclude that this was true also of the lower part, nearly to the West Haven shore? The slope of this lower part is no greater than that more to the northward; and hence there is little objection to the conclusion from this source. The bay is small and throughout shallow, being but 3 to 18 feet deep at low tide, and little of it over 12 feet; so that it did not afford a capacious channel for the escape of the flood waters.

2. *Height of the terrace-plain above flood-level in the estuary and river-valleys.*—About the New Haven bay, the plain, as has been stated, rises gradually to the northward. It reaches its greatest height above the lower flats or flood-plain of the streams near where they leave their valleys to pass through the plain.

A. *West River.*—The greatest depth of the cut along West River, or greatest height of the terrace-plain above the lower flats, exists near Westville, where it is 45 to 47 feet. Going up West River this height above flood-level diminishes to 33 feet in the course of a mile, and to 6 to 8 feet in the next half a mile: but this is due to the rapid descent in the stream, which is 22½ feet in the first mile, and 50 feet in the following half a mile, 72½ feet in all.

B. *Mill River.*—Along Mill River, the height of the terrace for the first mile and a quarter above the head of New Haven bay, that is, through the New Haven plain, is ten feet or so below the height normal to that part of the plain; and this was a consequence of the denudation by the Glacial flood, as before explained.* But at Whitneyville, near the dam, the height—or the depth of the cut—is 50 feet; and this continues to be the

* This volume, page 177.

epth up stream for the next mile and a half; and for the next ıree-fourths of a mile, or up to Augurville, the height is 45 :et. Toward Mt. Carmel village the height diminishes to 36 et above flood level; and then in the next half mile above to 5 feet.*

C. *Quinnipiac River.*—The terrace plain along the Quinni- iac near where it leaves its valley, or at the Air Line Railroad ut, is 43 feet. North of this lie the wide marshy flats, which ontinue for five miles to North Haven; and at the latter place ıe height of the terrace on the west of the river is but 45 et; the waters having stood nearly on a level between the orthern and southern limits of this great interior basin.

These are the facts from the river-valleys. Along each the ut made by the denuding waters since the Glacial flood is not ır from 45 feet. This depth of cut is just what would at the resent time result from the denuding action of the rivers, if ıe land were to be raised 45 feet or so—supposing there were o rocky ledges in the beds of the streams to prevent excavation ownward.

On the other hand, if the Glacial flood were vast enough to aise the waters to that level and so to build up (out of the ands and gravel within its disposal) the drift formation there xisting, without any aid from an elevation of the land, or of one f only 5 to 10 feet, then, when the flood had passed, the streams ould have sunk their beds to their present level, and so have ft the terrace-plain, where not more or less washed away, at its resent height above them.

Thus either hypothesis, (1) that of an elevation of 45 feet ince the Champlain period, or (2) that of the accumulation of tratified drift in the valleys to its present height by the Glacial ood, with little or no subsequent elevation of the land, will xplain the facts. If the former were the actual condition, then ıe waters would have continued their work, about the estu- ry or inlet, of building Champlain deposits up to, or toward ıe 45 foot level, through all the Champlain period, or until ıe elevation of the land closing the period began. If the lat- er, the sinking of the rivers as the flood subsided would have owered their working ground down to the existing level of ıose plains; and hence, little or no estuary deposits of the ıter or "Alluvian" part of the Champlain period, beyond a eight of 5 to 10 feet above high tide level, should be looked or.

For further evidence we proceed now to facts from the *struc- ure* of the beds of stratified drift, and from the occurrence of

* This diminution in the depth of the cut, or in the height of the terrace-plain, to ıly 15 feet, is owing to a trap ledge which crosses the bed of the stream in a line ith the trap ridge at Mt. Carmel; this ledge prevented excavation.

deposits of the later or "Alluvian" part of the Champlain period.

3. *Structure of the beds formed.*—Throughout the stratified drift-deposits of the New Haven region for four and a half miles north of Savin Rock on the West Haven coast, the finer beds of the stratified drift are characterized by the flow-and-plunge structure; and the oblique lamination in it—certain river valley regions excepted—*rises to the northward* (that is, dips to the southward). This *rising to the northward* I have attributed, in a former part of this memoir, to movement from the southward in the waters, that is, to plunging waves accompanying the *inflowing* tides—supposing that ordinary inflowing tidal waters may push up the sands of the bottom before them and so make ordinary obliquely-laminated layers dipping seaward or rising landward: and that, by the addition of plunging waves, the flow-and-plunge structure produced would also have the layers dipping seaward. That in such a case the dip of the little layer would be seaward I inferred, perhaps without due consideration, from the direction of movement in the water, and from observations long since made by me on the sandstones in the vicinity of Sydney, New South Wales.* If, as assumed in Part I of this memoir, the above conclusion is correct, the seaward dip of the oblique laminæ beneath the New Haven plain, up to a height of at least 45 feet, is proof that the sea was the agent, and that therefore the land at the time was at least 45 feet below its present level.†

Further, the deposits through the long Air-Line Railroad cut at the mouth of the Quinnipiac valley, have, as described on page 175 of this volume, the oblique lamination in the upper stratum of 20 feet *reversed*; that is, dipping landward instead of seaward; and this difference in the lower and upper strata naturally suggests that there was a change in the direction of movement of the depositing waters; a change from that of the inflowing tide to that of the outflowing flood, as stated on page 176, or, if the lower stratum was made by the flood, from the outflowing flood to the inflowing tide. Either way we reach the conclusion that at some time in the early Champlain period, if not through all of it, the land was at least 45 feet below its present level, and that a rise to this extent has since taken place.

Still certain facts dispose me now to question the inferences that oblique lamination made by the inflowing tide would have the dip in general seaward, and that the reversion of the dip

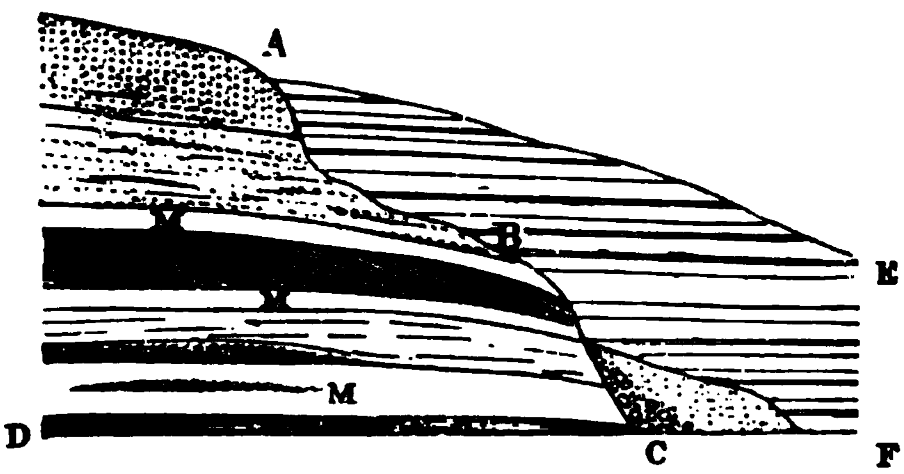
* See the writer's Exploring Expedition Report, 4to. 1849, pp. 465–523. The observations were made in 1839.

† Owing to the want of good sections I have been unable to study the character of the lamination over the Hamden Plains, where the height of the surface rises beyond 45 feet.

in the upper twenty-foot stratum on the Quinnipiac has no other explanation than a change in the direction of the current. Among them, I here mention only that I have observed several cases along river-valleys, out of the reach of the sea, of dip in both directions; and, in some of them, obliquely laminated layers dipping down stream had a thickness of several feet. Such facts bear against the view.*

4. *Alluvian Deposits*—Another fact favorable seemingly to the conclusion that the land remained 40 feet or more below its present level for some time after the Glacial flood had passed, is afforded by the existence of the deposit of horizontally-bedded white sands against the northward slope of the terrace of stratified drift at the northeast extremity of the Air Line Railroad cut, near south of East Rock. The figure is here reproduced

1.



Section of stratified drift, A C D, and later unconformable Champlain deposits, A C F E, Air Line Railroad cut.

that the relation of the deposit to the stratified drift may be appreciated. The conclusion, explained on p. 180, that the white sands were washed and accumulated on the south shore of a great "Interior basin" occupying the Quinnipiac valley, appears to be the only reasonable one; and if so, this "Interior basin" continued to exist for a while after the flood and flood-depositions had reached their height, as an area of high water. Yet, as the bed is of very limited extent and the terrace formation is generally free from Alluvian deposits, the time may have been only that of the latter part of the flood, prolonged after flood-deposition had ceased by the melting still going on to the north; and the region of melting may have been north of the head of the New Haven streams, since it is possible, as I show beyond, that the flood waters of the Connecticut and Farmington rivers overflowed into the New Haven region and bay.

5. *Conclusion.*—While the height of the terrace-plain above the sea and its height above the flood-plain of the river, fail of demonstrating that the New Haven region was below its pres-

* The gentle pushing of the waters over sands makes ripple-marks, or elevations having a seaward and a landward slope. The query now is whether, in the heavy pushing producing the oblique lamination, the laminæ would conform to the former or the latter of these slopes.

ent level in the Champlain period, the evidence from the structure of the beds and from the Alluvian deposits suggests that the region was submerged to a depth of at least 45 feet.

But if so deeply submerged, why should the terrace plain slope off gradually toward the coast and have no line of old beaches across it? And why is there no 45-foot sea-shore formation or terrace along some part of the bases of the hills?

The ways in which such a slope in the plain may be supposed to have resulted are the following:—(1) By a subsidence causing a bending downward of the coast-region after the elevation of 45 feet had taken place.—(2) By an elevation of the land which should be 45 feet four miles from the coast, but 10 to 12 feet near the coast.—(3) By the sweeping action of the flood giving a slope to the deposits toward the Sound and beneath its waters, and preventing the formation of seashore flats at the water's level.—(4) By the denuding action of the waves and tidal currents as the land rose to its present level.—(5) By the deposits, because of a diminution in the amount of material southward or increase in the depth of the waters, conforming in slope to the pitch of the surface on which they were spread out.

The first and second of these ways have little probability in their favor. The others I make the chief source of the result in my memoir on the New Haven region, saying (p. 99) after remarks on each method: "That part of the rapidity of slope in the lower portion of the plain below 40 feet in height is due to tidal, wave and river action over the region of the bay; and part to increasing depth over the borders of the bay southward and a decrease southward in the amount of transported sand." How far these methods are sufficient may be better considered after a survey of the facts from other parts of Southern New England.

2. The Lower Part of the Housatonic Valley

On page 409 I have stated that the height of the terrace of stratified drift in the Housatonic valley near Birmingham is 95 feet above high-water level. The terrace has the same height at Birmingham, and at the manufacturing village of Shelton on the opposite side of the river.* These places are situated at the junction of the Naugatuck river with the Housatonic. The Housatonic river comes down from the northwest, and the Naugatuck from the north: and on the point of land between

* For this altitude I am indebted to measurements by Mr. D. S. Brinsmade, of Birmingham, surveyor. The leveling was made at Shelton, and gave for the average height of the plain above low-water 106.64 feet. Mr. Brinsmade states that some points were five to eight feet above this. I have taken as the maximum height of the terrace 112 feet. The height of flood-level above low water seldom exceeds 17 feet, and this subtracted from 112 gives 95 feet for the height above flood-level. A higher flood, Mr. Brinsmade says, occurred in 1857, when the river rose to 22 feet 3 inches.

ies Birmingham, with Shelton opposite on the west (or south-west) bank of the Housatonic, and the village of Derby on the east bank of the Naugatuck. The streams rise in the high regions of Western Massachusetts and Connecticut, in part over 1000 feet above the sea, and flow in rapids through much of their course down to their confluence, where they reach tide-level, ten miles from the Sound.

As Birmingham is but nine miles to the westward of New Haven, it is improbable that the amount of elevation which the two places have undergone since the Champlain or Fluvial period should differ much; and hence there must be a special cause for the great height of the Housatonic terrace. For this cause we have only to look to the topographical conditions of the region.

Besides the fact of (1) the junction there of two rapid streams, whose united drainage area is about 1800 square miles, there are the following additional facts bearing on the subject:

(2) Both streams at that place have narrow terrace regions, the valleys between the hills having little width.—(3) On the east side of the Naugatuck the high bordering hills leave almost no space at their foot for the one-street village of Derby, so that the flooded waters cannot spread in that direction, and are naturally forced over against Birmingham and Shelton.—(4) The hills that lie back of Shelton, embaying its terrace region, reach to the river just below the village, and so do those on the Derby side, making thus, below Derby, a comparatively confined passage for the united waters, which has long been called the "Derby Narrows."—(5) The river channel below Derby, through its ten miles to the Sound is very shallow, being navigable for vessels drawing four feet of water only at high tide; and besides there are sandbanks at its mouth reaching a mile and a half beyond.—(6) The terrace along the valley below the Narrows is narrow for nearly seven miles out of the ten, the width in no part exceeding two-thirds of a mile.

Under such circumstances it is natural that the waters of the Glacial flood plunging down the two valleys should have entered the region of Birmingham and Shelton faster than they could have escaped. The fact that a cataract of great volume passed the region of Birmingham and dashed violently against the Shelton shore is abundantly manifested by the multitudes of large water-worn rocks and thick coarse cobble-stone deposits in the upper portion of the lower as well as high upper terrace, and in the imperfect stratification of portions of the deposits.

Even modern floods in the region bring down waters faster than they are discharged through the Derby Narrows and the channel beyond. The Housatonic river below the confluence

has almost no slope at high tide, the tide reaching that point. Yet a spring flood often produces a rise of 17 feet at Shelton, and causes an average pitch in the river's surface for the ten miles to the Sound of nearly 1¾ feet per mile; and there is occasionally a flood causing a rise of 22 feet, and consequently an average pitch of more than 2 feet a mile.

To ascertain the average pitch below Birmingham or Derby for the Glacial flood we have important data in the height of the upper terrace between these places and the Sound.

The Shelton and Birmingham level of 95 feet extends below Derby to the "Derby Narrows." Below the Narrows—about 1¾ miles from Shelton and 1 mile from Derby—the valley on its *east* side expands rather abruptly about the mouth of Two-mile Creek; it then contracts again on that side, through the rising of "Turkey Hill," but regains its expansion below through the retreat of the hills on the *west* side.

Now the terrace below the Narrows, just north of Two-mile Creek, has a height of 75 feet above high-water mark; and a mile below this, on the west side, of 70 feet. Hence, in passing the Derby Narrows, a distance of three-fourths of a mile, the level appears to have fallen 20 feet, which would indicate a tremendous rush of waters between the rocky hills.

The following table contains the heights of the terraces as measured along the valley to the Sound, the above included:*

			Feet.
At Shelton, opposite Derby			95
1 m. below Derby, east side, below the Narrows			75
2 m.	"	west side	70
4 m.	"	east side	50
5 m.	"	east side	46
6 m.	"	west side	43
6·8 m.	"	west side, near a stream	35

[redacted]

is, however, proved, and the general amount of pitch seaward deduced cannot be far from the truth.

For determining the actual amount of elevation along the lower Housatonic since the Champlain period no satisfactory data have been obtained. It is plain that the height of the terrace at Birmingham is a measure chiefly of the vastness of the flood, and that the "necessary deductions" for reducing it to a measure of elevation are very large. The evidence with reference to the elevation derivable from the structure of the beds could not be studied for want of sections. The wide extent of the thirty-foot terrace-plain suggests that it may mark the Champlain water-level; but of this other proof is needed. The formation of the seashore terrace would not require an elevation of more than 12 or 15 feet.

3. The Lower Part of the Connecticut River Valley.

The height of the stratified drift deposits in the Connecticut River valley at Middletown, 150 feet, seems, at first thought, to be evidence of a very great change of level since the era of deposition, much greater than in other parts of Southern New England. But what part of the rise in the waters was due to the great flood? The Connecticut River passes through the whole length of New England from north to south, and has a drainage area of about 20,000 miles. The melting glacier would have continued to augment its waters through its long retreat from the Sound to the borders of Canada.

First, a few words on the condition of the river supposing the Glacial flood to have raised the waters to the height mentioned; and, then, the facts which prove that such was the height and extent of the flood.

The Middletown region, 30 miles from the mouth of the river, with the floods at a height of 150 feet above the modern flats would have been in the condition of a lake one to four miles wide, and over part of the area, 100 to 150 feet deep. This Connecticut valley lake would have extended northward, narrowing and having shallow borders between Cromwell and Glastenbury (or between 3½ miles and 11 miles from Middletown), then widening again so as to cover an area a dozen miles in width about Hartford. I am informed by General T. G. Ellis, recently in charge of the Government Survey of the Connecticut River, that the stream at low-water at Hartford (15 miles north of Middletown) is on a level with mean low water in the ocean. Passing Hartford, it would have continued to Springfield and beyond; but it was probably in this part a broad rapid stream, with shallow borders most of the way on either side of its main channel, and having part of the pitch of the present stream, about 38½ feet in its course between

Springfield and Hartford, a distance of 24 miles. The whole width of the waters at Springfield was probably greater than at Hartford, although averaging much less—as the height of the terrace near the river shows—in depth. The Springfield level extended 10 miles to Holyoke, where are the South Hadley Falls of 60 feet.*

The evidence as to the reality of this height and of the great breadth of the waters is as follows:

Three-and-a-half miles north of Middletown, east of the river, a broad terrace rises boldly from the river to a height above flood-level of 144 feet,† and the wide plain continues, with a nearly even summit, though mostly of greater height 150 and 155 feet, to Glastenbury, eight miles to the north. The road from Middletown to Hartford on that side of the river, for the most of the way, is on the terrace. In addition to its level features, there is other proof that the formation beneath is the true stratified drift in its consisting, as shown in sections, of stratified sands and gravel. A terrace at very nearly the same height exists also for part of the way on the west side of the river in the town of Cromwell. The coarse nature of the beds comes from the rapid flow of the waters, and this from the little depth over the region where they were deposited—a fact made manifest by the sandstone rocks showing themselves occasionally through the plain. About Middletown, where the depth was great, the deposits consist of fine earth and clay.

Prof. Hitchcock, in his "Surface Geology," gives the height of the South Glastenbury "terraces" as 175 feet above the river, which would be about 152 feet above flood level.‡

In the city of Middletown, the corresponding terrace is de-

* Nearly [illegible]2 feet out of the 38½ of descent between Springfield and Hartford is made along Enfield Falls, beginning 8 miles below Springfield and continuing for 5 miles over a rocky bottom.

The height of the Holyoke dam at either end is 97·60 feet above low-water mark at Hartford, or near low water in the ocean.

The tide up the Connecticut River is sometimes noticeable as far as Windsor Locks, at the lower limit of Enfield Falls, 10 miles north of Hartford. The highest in summer at Hartford, [illegible] miles from the mouth of the river, has a range of about 10 inches, and that at Middletown, of [illegible]·93 feet.—*Gen. T. G. Ellis, in Reports U. S. Engineer Dept. for* 18[illegible] *to* 1874.

† For the height of the terrace at this point I am indebted to a leveling by the following persons connected with the Sheffield Scientific School: Mr. G. W. Hawes, assistant in the Mineralogical department, and H. A. Miller, H. Hun, and A. B. Howe.

‡ Prof. Hitchcock suggests in his "Surface Geology" that the terrace at South Hadley of "[illegible]92 feet above the ocean, and that at Willimantic of [illegible]268 feet" slopes southerly, and corresponds with that of "[illegible] feet at Springfield and Long Meadow ([illegible] feet above the river), that of East Windsor of [illegible]96 feet, and that of Hartford of [illegible] feet" above the ocean. Such a slope is impossible, and further the wide Glastenbury terrace, which he here leaves out of consideration, proves it not to have been a fact.

ween High street and the next street west, north of the of the Wesleyan University, and has a maximum height 150 feet; and these grounds, excluding a portion in the t corner, are part of it. A terrace two miles east and of Middletown, above where the river narrows, I have the same height—150 feet.

liately around the city of Hartford the plain is mostly feet above high flood-level in the river (70 to 90 above r); and in many places it consists of clay to the top. ond three or more miles there is a rise to higher levels. west of Hartford, along the Connecticut Western Rail- plain is extensive 6 to 7 miles out at a height near 130 between 9 and 9½ miles, at a height of about 160 feet.* f Hartford, the terrace has a maximum height near ter, 7 miles out, of 155 to 160 feet.

southwest of Hartford, the extended New Britain plain et in height above the same base—high flood-level in .†

acts appear to point to a height of about 160 feet for er terrace of the Connecticut valley, that is, for the ood, in the vicinity of Hartford.

n miles south of Hartford, on the railroad route to New he broad divide between these two cities—1½ to 2 miles Meriden—has its highest part made by a terrace of drift, (rising 20 to 21 feet above the railroad track); e is about 185 feet above mean high tide at New Haven, feet above flood-level at Hartford, and it is probably, a Connecticut River terrace;‡ and since it has a depth than 20 feet, the Connecticut during the glacial flood ve lost some of its waters by their spilling over the to the Quinnipiac valley and river.§

from Mr. W. H. Yeomans, the Superintendent of the Connecticut ilroad, that the height of the track 9½ miles out, near Scotland, is 190 mean tide level, which is equivalent to about 160 feet above highest rtford.

J. Pierson, of Meriden, has informed me that the height of the New n is about 172·25 feet above mean sea-level, which is 169·12 feet above ide, and about 142 feet above highest flood-level at Hartford.

ing from Meriden to the divide, for the height of the divide above the Main street and the railroad in Meriden, gave Mr. S. C. Pierson 43·64 , with 121·50 for the height above mean high tide, and 20 feet for the s for the height of the divide above high tide, about 185 feet; or 158 he Hartford flood-level. A careful barometric measurement at Meri- E. S. Dana, obtained for the height of the track by the Meriden depot ide, 127·3 feet; which would give 191 feet for the whole height of the high tide, and 164 feet for the height above Hartford flood-level.

dence favoring the view that waters from Farmington River poured Quinnipiac during the glacial flood is even more conclusive. Prof. as suggested (Rep. Geol. Mass., 329) that the Connecticut may have to the Farmington along a route west of Mt. Tom and over Westfield.

At Springfield, within a mile or less from the river, there commences the great terrace of the region—a plain several miles wide—having a height, as I am informed by Mr. G. A. Ellis, city engineer, in general between 140 and 145 feet above flood-level in the river (the higher floods raising the river about 22 feet), or about 200 feet above high tide. But this wide terrace shows, by the fact that the material of it is mostly fine sand and clay, that it was made in comparatively quiet waters before the flood was at its height, and that it is probably not the highest. Beyond three miles southeast, east, and northeast of Springfield there are hills of stratified sand and gravel, rising to a height of 180 feet above flood-level, which belong to the *upper* terrace, and mark more nearly the flood's height. I learn from Mr Ellis, to whom I am indebted for a map of Springfield and its vicinity for ten miles around giving the amount of elevation for a large part of the surface, that this 180-foot level (or 170 to 190) occurs in hills made of hardpan near the Boston and Albany Railroad, 8 miles from the Springfield depot; and south of this, near the "Old Bay Road." A level of 180 feet occurs along the same railroad between 6 and 9 miles from the depot, or for 3 miles east of Jenksville. Traversing the region with Mr. Ellis, he has shown me that the 180-foot level extends from Jenksville northward, with little variation, toward the Granby line, over four miles, if not beyond, and westward five to six miles to the Connecticut river. At Willimansett, on this part of the river, Prof Hitchcock measured the height of the terrace and found it 172 feet above flood-level (or 194 feet above low water) and at South Hadley, two miles north of Willimansett, he found nearly the same height.

The upper terrace is therefore not less than 180 feet above flood-level in the river (or 237 feet above high-tide level in the Sound,) and probably this is very near the true height.

Ten miles east of Springfield, at Collins Station on the railroad, there is a plain, as Mr. Ellis informs me, at a height of 210 feet. But this is partly confined by the Wilbraham Hills and is properly the terrace of the Chicopee river, which is but three-fourths of a mile distant. From Mr. Ellis I learn further that in Westfield, 10 or 11 miles west of the Connecticut, the land rises into a plain of great extent, being two miles broad "widening between Westfield and the point where Westfield Little River leaves the town of Russel," which has a general elevation of 205 above flood-level in the Connecticut, or, 262 feet above high tide, "corresponding very closely with the plain-region the same distance to the east of Springfield." *But this Westfield plain is in the Westfield valley, and is* properly a Westfield river terrace. Yet if these higher flood-grounds, extending to a distance of 10 miles on the east and west, were outside of the limits of the Connecticut flood, they

cate that the waters were pouring into the central trunk 'ast volumes from the regions either side, and also that the e flooded condition characterized all New England valleys. 'he depth of the flood-waters and their great width along Connecticut valley cannot therefore be questioned. Now ıt does this great height of the upper terrace indicate with ırd to the depression of the land when the deposits were le, or the elevation since that time? What are the "neces- r deductions?"

. Two miles below Middletown, the Connecticut river passes veen high and steep rocky slopes, and has a width of but 400 ls; and when the old flood was at its height, the width even then not over 500 or 550 yards, not a tenth of that at dletown. These "Straits" or Narrows extend for two-thirds mile; there is then some widening on the east, and a mile ›w, as much on the west, giving room for the terraces of dle Haddam and Maromas. Thence the valley continues thward with more or less room for a terrace on the west side little or none on the east, the valley, reckoning to the ts of the terrace, seldom much exceeding half a mile in th.

'he Narrows below Middletown, like the Narrows on the ısatonic below Derby, had evidently much to do with de- ıining the great height of the flood-waters above The ers could not pass off by the contracted outlet as fast as plied by the melting glacier, although this outlet was over urth of a mile wide; and hence the waters were piled up ı over the back region. This effect is imitated on a small e with the melting of the winter ice and snow causing the ng floods; the water at Middletown increases its height ıe highest floods about 25 feet, which is equivalent to in- sing its average pitch thence to the Sound by five-sixths of ot per mile.*

'here is evidence that a very large part of the 150 feet was ıally due to the flood. This is found in the descending

[*] The height of the floods at Hartford is 4 to 5 feet above that at Middletown. ɜ to General Ellis the following table of flood heights at the two places. The water at Middletown from which they are measured is 1·3 feet below the zero ırtford, and the latter is ·045 foot below mean sea-level.

Flood of		1801,	Hartford,	27 ft.	6 in.	Middletown,	23 ft.	8½ in.
"		1843,	"	27 "	2 "	"	22 "	11 "
"	April,	1852,	"	23 "	1½ "	"	19 "	5 "
"	Nov.,	1853,	"	20 "	6 "	"	17 "	2 "
"	May,	1854,	"	29 "	10 "	"	25 "	8½ "
"	Aug.,	1856,	"	23 "	4 "	"	18 "	1 "
"	March,	1859,	"	26 "	5 "	"	21 "	10 "
"	April,	1862,	"	28 "	8 "	"	23 "	9½ "
"	March,	1865,	"	24 "	9 "	"	20 "	00 "

ɜmarks further that the average difference of the heights of the nine freshets ؛eet 3½ inches, and the slope of the surface would be 1·3 feet more than the ence of the heights.

height of the uppermost terrace of stratified drift along the river to the Sound. The heights, on the west side of the Connecticut, going *southward*, are as follows:*

2 m.	below the Narrows,		the Maromas plain	133½ ft.
5 m.	"	"	near Higganum	100–105 "
7½ m.	"	"	near Haddam station	82– 85 "
10½ m.	"	"	near Goodspeed's station	75 "
14 m.	"	"	near Chester station	60– 62 "
20 m.	"	"	1½ m. below Essex	42– 45 "
22½ m.	"	"	near ferry and railroad	30– 31 "
24½ m.	"	"	Saybrook Plain	20– 21 "
26 m.	"	"	Seashore House, on Sound	13½"

The plains, the heights of which are here given, were well displayed, leaving no doubt that they corresponded to the true terrace; and they were the highest in each region. They show that, from the Narrows, the river waters plunged along with a pitch of several feet a mile.

It may seem almost incredible that waters so violent should have made terraces in many places along the sides of the narrow valley. But the material of these terraces—mainly sand and coarse gravel, and the coarser above as usual—was to a large extent washed in from either side by the waters descending the side valleys, ravines, and all sloping surfaces; for there was gravel and sand everywhere over the hills from the dissolving glacier, and water everywhere in profusion for the work of transportation. The waters merely stratified and leveled off at top the material thus contributed. Moreover, we can follow the rise of the flood in the succession of the deposits; in clays, in some places, near the bottom—one bed supplying a brick-yard just below the Narrows—made when the waters were yet low; the sands next deposited while the waters were rising; the fine and coarse gravel mostly above—at the top of the lower, as well as of the highest terraces—spread out when the flood was at its height. The Middletown region is mostly one of fine earth, and the sand and gravel of the terraces below the Narrows could not have been carried over it by the stream, without making large depositions,—except in ice-floes, and these certainly did little of the transportation in the case here referred to.

Finally, how far was the height of the terraces described due to an elevation of the land since the beds were deposited?

Judging from the seashore terrace, on Saybrook point, the elevation of the land did not exceed 15 feet. I have not succeeded in finding other evidence on this point.

* The height of the Maromas plain was determined by levelling, by Messrs. Pillsbury and Clarke, of the Wesleyan University. They obtained 133½ feet above flood-level. The extended terrace on the opposite (east) side of the river has about the same height. The other measurements were made by the author.

4. The River Thames.

The conditions of the stratified drift deposits of Norwich are nilar in several respects to those about Birmingham. Two 'ers from the northward, the Quinebaug and the Yantic, pass her side of the city and unite below it to make the Thames. ıey rise in Massachusetts, and have nearly the same drainage-ȝa as the two that join at Birmingham. They descend from ʒh land and most of the way in rapids. Immediately below ›rwich the valley is so narrowed by hills over 150 feet high ıt the width of the river, were the water 100 feet above present level, would be hardly half a mile. But below these ırrows the valley expands, though still closely bounded high land. The points in which the two cases differ are ȝse:

(1.) The Narrows have greater width, and the modern eam below has much greater depth as well as breadth: the annel being one of the tidal, navigable fiords of the coast, the .es at Norwich having a range of more than three feet. Con-ɿuently it offered the flood-waters a less contracted way to e Sound.

(2.) The distance from the Narrows to the Sound is greater, ing 14½ miles.

(3.) Although this distance is so much greater, the highest ring floods cause a rise above high tide of but 7½ feet—much ıs than half that in the Housatonic at Birmingham.

Again, (4,) the terrace plain of upper Norwich—the site of oadway and its many fine residences—has over its northern rt (at the foot of the little triangular Green) a height above .e level of 117 feet;* and, since the spring floods raise the ıter but 7½ feet above high tide, about 110 feet above od level, against 95 feet at Birmingham.

The height of the Norwich plain above flood level diminishes ›m 110 in its northern part to 101 feet in its southern, a dis-ıce of about a mile; and this is very nearly the level of the race to the eastward of the latter at the Old Cemetery. The ›rwich plain is so extensive, and the deposits so clearly con-t of bedded sands and gravel, with the flow-and-plunge 'ucture in some places quite to the top, that there is no occa-ın to doubt the statement that the water once stood at its ʒh level. And since the deposits—those beneath the Old metery, for example,—are made up in places of the coarsest ıvel, the waters were the hurrying waters of a great torrent.

That this was the actual condition is proved further by the ights and nature of the terraces below Norwich. For they

* I have these numbers from the Water Commissioner of the city of Norwich, . Winship. I have been much aided in the study of this region by a map of Thames, giving contour lines for 50, 100 and 200 feet, which was furnished by the Superintendent of the Coast Survey.

declined southward, precisely as in the Housatonic and Connecticut River valleys. The heights are as follows:*

Highest part of Norwich Plain,			110 feet.
1 m.	South,	on Norwich Plain,	101 "
2¼ m.	"	at Thamesville, below the Narrows,	88 "
5¼ m.	"	near Mohegan R. R. Station,	75 "
8 m.	"	½ m. W. of Montville R. R. Station,	61 "
10½ m.	"	in Smith's cove, 250 yds. W. of R. R.,	50 "
13½ m.	"	at New London, northeastern part,	24–25 "
14 to 16 m.	"	between New London and the Lighthouse, none distinct.	

Below the Narrows the valley opens widely on the west about Thamesville, and consequently has there a broad terrace. The same is true also of the region and terrace of Montville where a lateral valley comes in. The material of the upper part of the formation on the river near the Montville railroad station is very coarse, some layers being made up largely of cobble stones. On the point just north of Smith's Cove, the terrace is only 25 to 27 feet high; but it shows that it is below the normal height by its stony character: and, further, just around the point, 250 yards inside of the Cove, there is a much more extended terrace at a height of 50 feet, made of finer material.

The terrace in the northeast part of the city of New London (near where the track of the Northern Railroad leaves the city) is also very stony, and must be below its normal height, and probably as much as ten feet.

In passing the Narrows to Thamesville the decline of the terrace plain is 13 feet, and below Thamesville to Smith's Cove, on an average nearly five feet per mile. This last pitch if continued to New London would make the normal height there 35 feet instead of 25 feet. The terrace is equally low on the east side of the Thames in Groton; but it is also very narrow there, little room existing at the base of the hills for a terrace.

South of New London, between it and the Sound, I saw no distinct terrace.

The decline southward in the height of the terrace plain, as in the case of that along the other rivers, does not suggest marine action as the means of deposition. It manifestly points to the pitch of flowing waters in the channel. and to such a flow as could exist only in a period of incredible floods—when an outlet averaging over half a mile in width was not wide enough to discharge the waters coming from the hills and valleys within a range of forty miles.

* For the height of the plain near the Montville Station, I am indebted to a levelling by Mr. C. P. Jennings, Surveyor of the city of New London.

Direct evidence as to the actual level of the coast about the mouth of the Thames during the era is wanting; both because of the absence of a seashore terrace, and because no sections were exposed along the Thames that afforded a chance for studying satisfactorily the character of the bedding. But if the New London Lighthouse Point is without terraces, I have seen several examples of them at the head of broad bays between New London and Stonington, and in no case have I found the height over 15 feet, and generally it is but 10 or 12 feet. Again, Fisher's Island—about seven miles in length—lies off this same coast, and within five miles of it; and at the head of West Harbor, there is a well defined shore terrace of 15 feet; and, at East Harbor, one of less certain nature nearly 25 feet. 25 feet is therefore the greatest height inferable from this kind of evidence, and 15 may meet the facts.

5. Narragansett Bay.

Providence is situated on Providence River within a mile of the head of Narragansett Bay. Its terrace, averaging 80 feet in height above high water, is extensive, and part of the city is built upon it. The river opens into the broad northern arm of the Bay, and affords 14 feet of water for shipping to the city. The Bay has passages one to three miles in width among its islands, and enters the Sound about 26 miles south of Providence. With so open a passage for the waters we might infer that certainly the Providence terrace must mark a sea level of the Champlain period. But in view of the facts detailed in the preceding pages it is evident that something of this height is attributable to the flood descending the river valleys.

I have not been able to study carefully all the shores of the great bay with reference to its terraces. Ten and a half miles south of Providence, east of East Greenwich, there is a very wide terrace-plain, which extends south toward Wickford. Near the railroad in East Greenwich, the height is 56 feet, showing a loss of 24 feet of elevation in the 10½ miles from Providence. At Wickford, 7 miles farther south, the height is much less, little exceeding 30 feet.

There is a terrace at Fall River, on the west shore, about 17 miles from the Sound, and between this place and Tiverton. The height, just below the depot at Fall River, is 35 feet above high water; but the beds are very stony toward the top, and hence it is that the terrace is 30 feet below the normal height; some of the stones are a foot in diameter. The terrace south of Fall River has no greater height. About Newport there appeared to be no well defined terrace.

But direct evidence bearing on the height of the region in the Champlain period is afforded by the coast region between

Point Judith (the west cape of Narragansett Bay) and Watch Hill (the cape south of Stonington). Along much of this shore, as stated on page 411, there are wide flat meadows between the hills and the sea, having a height of about 11 feet above high tide. The road passes between these flat meadows on the south, and the bowlder-covered hills on the north, and the contrast is very striking: the former sandy or gravelly and thinly grassy among the great bowlders, the latter having an even dense turf over a rich black soil. Above the level of the meadows no trace exists of sea-shore flats or beaches; the stony hill-sides rise gradually, with nothing about them to suggest a Champlain submergence.

Off this shore, one to two miles, there is a sandy barrier; rising into hills to the westward, and it may be questioned, therefore, whether the meadows may not owe a part of their height to the flood waters. But the black soil appears to be evidence that they long lay with the surface at the sea-level, perhaps as a salt marsh of the Champlain period. Large portions are thickly strewn with broken oyster shells, left by the Indians, and this may be one source of the fertility.

No marine relics have yet been found in Champlain deposits about any part of Narragansett Bay to mark the sea-level. Such fossils should be looked for with more care than has hitherto been used; but much looking will probably end in finding none. The great glacier must have filled the channels among the islands; and as the ice disappeared, the floods, having a strong pitch owing to the height at Providence, would have made a profound sweep through them. Absence of marine fossils is therefore what should reasonably be expected.

An 80-foot terrace at Providence, a 56-foot terrace at East Greenwich, and an 11-foot plain on the sea-coast with no trace of any other terrace-level on the coast hills, are the positive facts gathered from the vicinity of Narragansett Bay.

6. Pre-glacial Sand-hills.

To define more clearly what are true deposits of stratified drift of the era of the melting in Southern New England, I add a few remarks on certain sea-shore sand-hills, that are easily mistaken for drift formations. I refer to ridges and hills of stratified material along the shores between Watch Hill and Point Judith.

It has long been known that Martha's Vineyard consists largely of Tertiary sands interstratified with clays, unconsolidated—except in some places through limonitic depositions making a limonitic or iron conglomerate. Block Island, Long Island, and Fisher's Island, just off the New England coast, are also made up to a great extent of such unconsolidated

›-glacial beds,—as I shall more particularly explain in an-
ıer memoir.

The New England coast region, from Watch Hill eastward, but a continuation of Fisher's Island, in its features, and ›o, as there is reason to believe, in its Tertiary deposits. Its ls or ridges are of various heights, up to 180 feet; and noth- ; besides unconsolidated, though bedded, sand, gravel and ıy, occurs in their constitution. Clay-beds are not in sight. ıt near the Ocean House, one of the large Watch Hill hotels, ›ond, near the sea-level, is called Clay pond, because of the ıy beneath the water; and I am informed by a resident in ; region, that masses of clay are sometimes thrown up by ; sea on the beach, showing that it exists at the base of the ıd hills.

Over the stratified material of the hills lies the unstratified ıft, with multitudes of large bowlders .

These hills show that they do not consist of Champlain or er deposits by the following characteristics.

In the first place, the hills are, as stated above, covered ›oughout with bowlders, down to within 10 or 12 feet of the ı level, and this demonstrates that the hills were there before ; deposition of the bowlders and the associated gravel and ıd.

Further, the features as to the bowlders and the hills are ›t those of Fisher's Island, which lies in their line at a dis- ıce of only three miles to the west;—and not that distance, ıce there are intermediate islets and reefs connecting the two; d on Fisher's island the clay beds and sand beds which derlie the top-dressing of unstratified bowlder drift are in ne places upturned and folded—proving thus their anterior gin.

We may hence set aside those sea-border ridges as not of the amplain period, and regard them as prior in elevation even the Glacial period. Only the low grassy plain at their foot ›ng the shores is of the Champlain water-arranged drift mation.

Conclusions.

Fhe observations described in the preceding pages relate ly to five of the river valleys of Southern New England. though I have made no systematic measurements of terrace- ghts in other valleys, I have seen enough in many of them assure myself that all have the same class of facts to afford. e conclusions which are here reached with regard to the er floods are therefore conclusions for all Southern New gland, and beyond this, I believe, for all New England, and ıer regions covered by the great glacier.

1. The first question before us is—What was *the amount of depression* in Southern New England during the melting of the glacier.

The evidence that some elevation took place in Southern New England after the Champlain period, based on the existence of elevated flats along its sea-border, we may regard as conclusive. The height of the marine terraces where not modified by fluvial action varies between 5 feet and 25 feet, and rarely exceeds 15 feet. Taken alone, this affords no ground for believing that the elevation was less than 10 feet or greater than 25 feet. I think that 15 feet is the most reasonable inference, for the portion of the coast considered in the preceding pages.

The evidence derived from the structure of the bedding in the New Haven region—that is, the direction of the dip in the flow-and-plunge portion (p. 418) appears to be good; but since it is difficult to believe that the coast region of the Champlain period should have had no flats at the water level, to be placed, by an elevation of 40 feet, at a height of 40 feet, it is hard, in the absence of such terraces, to set aside all doubt with regard to that evidence. Hence, although at present unable otherwise to explain those facts, I am led to hold the conclusion in abeyance. This doubt is in opposition to my former statements. But those statements were based mainly on a study of the New Haven region, and the few facts from Connecticut previously on record. A decline in the height of the terrace-plain toward the Sound down to only 5 feet of elevation at the coast, along an estuary receiving three streams swollen by glacial floods, seemed to be accounted for satisfactorily by the sweeping action of the floods, and the erosion by waves during the progress of an emergence. But now that we know that such a seaward pitch in the terrace plains exists along all the valleys of Southern New England, and that the sea-coast terrace is universally but 5 to 20 feet in height, those causes appear to be inadequate. It is difficult to believe that they could have prevented so completely the existence of shore plains above the low height mentioned, through the whole line of coast, even (1) where no rivers sent down their floods, and (2) where distant barriers protected the shores from the heavier seas. Were the land 40 or 50 feet below its present level, as hitherto supposed, some of the islands off the coast would still have been a shelter from the heavier waves; and many of existing shore-hills would have been islands, protecting an inner region wholly from violent seas; so that deposits at or near a 40-foot or 50-foot level might well have been formed. And yet none such exist.

In the present state of the facts I therefore think that the

argument for an elevation of only 10 to 20 feet is the strongest, although not yet decisive.

2. *The river-valley formations not marine.*—The ocean took no part in the formation of the river terraces. The pitch in the terrace plains of the lower Housatonic, lower Connecticut, and the Thames, is alone sufficient evidence against marine action in the matter.

3. *The height of the flood the chief cause of the height of the terraces.*—The facts from the valleys of the Housatonic, Connecticut and Thames prove that the river-valley formations—which now stand at so great a height above the river's surface—were not wholly, or for the greater part of their height, formed *when the land was at a much lower level than now;* but, on the contrary, that they were formed *when the river's waters were at a greatly higher level than now,* and as a consequence, chiefly of the glacial flood. If the whole elevation of the land since they were made is but 15 feet, then the rest of the elevation of the high terraces was owing to the height of the flood.

The facts hence teach that we may have high terraces along valleys, and many terraces, and yet none be due to an elevation of the land. Further, the height of the lower terraces of stratified drift is *comparatively* of little geological interest. For, in New England, they cannot be proved to have had anything to do with successive stages of elevations; and, in general, they were underwater flats of different levels; or they originated as levels up to which the flood, according to its rate of flow, built the stratified material, or down to which they swept off that which had before been laid down; or they mark the level of oscillations in the height of the flood after this had reached its height.

4. *Height of the streams during the flood.*—The height of these valley formations above *flood-level* has been stated on preceding pages.

The following table contains these heights, and also the corresponding heights above mean *high-tide level.*

	Above flood level.	Above high-tide level.
On the Housatonic, at Birmingham,	95 feet.	110 feet.
On the Connecticut, at Middletown,	150 feet.	170 feet.
" " at Hartford,	160 feet.	185 feet.
" " at Springfield,	180 feet.	237 feet.
On the Thames, at Norwich,	110 feet.	117 feet.
Head of Narragansett Bay, at Providence,	80 feet.	80 feet.

To obtain the actual height above high-tide level, these numbers should be reduced by whatever was the amount of depression of the coast region during the Champlain period—that is by 15 feet, if that was the true amount.

Another reduction also is required.

The heights of shell-bearing beaches on the coasts of Massachusetts, Maine, the Labrador coast, Lake Champlain, and the St. Lawrence, show that the amount of depression in the Champlain period (or of elevation since) *increased to the northward.* If this was true along the eastern coast of New England, it was probably true also for the interior; indeed, Lake Champlain and the St. Lawrence at Montreal are part of the interior. Since the height of these beaches at Montreal have been shown by Dawson to indicate a depression there of 500 feet, and since that on the Sound was certainly not over 45 feet, and probably not over 15 feet, the average rate of increase from the Sound northward was about *one foot and a half* a mile.*

Adopting this as the average rate, the amount of depression in consequence of it was increased at Birmingham, 10 miles from the Sound, by 15 feet.

At Middletown,	20 miles in an air-line,	by 30	feet.
At Hartford,	35 miles, "	by 52½	feet.
At Springfield,	58 miles, "	by 87	feet.
At Norwich,	15 miles, "	by 22½	feet.
At Providence,	28 miles, "	by 42	feet.

Providence, though 26 miles from the Sound, is 28 miles from a line having the course of the shore meadows west of Point Judith.

With an increase northward, in the depression, of only 1 foot a mile, the depression derived from the source here considered, would have been *one-third* less at each of the places.

5. *Pitch of the stream during the flood.*—Owing to this depression, the pitch of the streams seaward was diminished. From the above numbers we obtained for the *average* pitch of the rivers to the Sound approximately:

8	feet per mile below	Birmingham.
4·5	" " "	Middletown.
5	" " "	Norwich.
1	foot " "	Providence.

In the highest modern floods, the pitch is about two feet below Birmingham; nine inches below Middletown; six inches below Norwich; and not over one inch below Providence.

* This subsidence, so much greater to the north over New England than to the south, must have occasioned, as I have stated in other places, nearly or quite a cessation in the movement of the glacier; and in this condition the ice appears to have melted away. One important consequence of this is the absence from New England of all terminal moraines. Terminal moraines are made from long-continued successive depositions of moraine-material (rocks, gravel, sand) at the terminus or melting-place of the *moving* glacier, and were there no motion none would form. On this account, the subject of terminal moraines has not been included in this memoir on "Southern New England during the melting of the great glacier."

Or, supposing the rate of increase of depression northward over *Southern* New England only one foot per mile, or less than farther north, the pitch would have been approximately:

8·5	feet per mile	below		Birmingham.
5	"	"	"	Middletown.
5·5	"	"	"	Norwich.
1·5	"	"	"	Providence.

If the land were 15 feet below its present level along the southern coast of New England, and the average rate of increase of depression northward were 1 foot per mile, the height of the flood waters above high tide would have been

At Birmingham,	85	feet.
At Middletown,	135	"
At Hartford,	135	"
At Springfield,	164	"
At Norwich,	87	"
At Providence,	37	"

It hence appears that, with 1 foot a mile as the northward increase of depression of the land, the waters would have been at Hartford on the same level as at Middletown; and at Springfield, but 29 feet above the level at Hartford, instead of 38½ feet, the present difference; and the pitch from Springfield to Hartford would have been about a foot a mile. With 1½ feet a mile of increase of depression northward, the flood at Springfield would have been only 10 feet higher than at Middletown.

7. *Glacial conditions.*—Whatever the rate of increase northward in the depression, and whatever the amount of actual depression along the Sound, only a small part of the marvellous in the glacial flood is removed. The rivers in the lower parts of the Housatonic, Connecticut and Thames valleys were cataracts on a scale beyond all modern knowledge. The waters from the melting glacier must have been poured down the streams in vast volume to have piled to so great heights before outlets so wide and so deep. And such facts are but examples of a condition that prevailed generally over the glacier-covered lands.

6. *The Champlain a Fluvial period.*—It is to be remembered that the glacier consisted of the precipitated waters of many thousands of winters, each winter, too, a year in length. Hence, when the melting reached its height, some centuries of precipitated moisture were let loose at once. The results from the action of the great rivers of the era are registered in the height and width of the valley formations. The Champlain was eminently the Fluvial period of the earth's history, while *pluvially*, or as it respects rain, it may not have exceeded the present time.

This last section of my Memoir, which purported at the outset to treat of the amount of depression of the land during the melting of the glacier, has turned largely into a discussion of the evidences and effects of the Glacial flood—the subject of the first section. This is a consequence of the fact that the extent of the upper valley-terraces afford stronger testimony to the flood than the material of the beds, enabling us even to deduce the depth and spread and pitch of the flowing waters through the New England valleys, large and small.

In another paper I propose to present other facts on this and connected topics derived from Long Island and the associated lands off the Southern New England coast.

ART. LIII.—*Ammonia a constant contaminant of Sulphuric Acid;* by F. H. STORER, Professor of Agricultural Chemistry in Harvard University.

IN reflecting upon some of the reactions by which ammonia is known to be formed, it occurred to me that this substance would very probably, or perhaps necessarily, be produced in the ordinary process of making sulphuric acid, and that it might remain as a contamination in the acid as used in the chemical arts. Acting upon the idea I have myself tested and have caused to be tested carefully and methodically a considerable number of samples of sulphuric acid obtained from different chemical works, and have found that every one of the specimens examined contained appreciable quantities of ammonia. I find, moreover, on looking the matter up, that the observation is not new, inasmuch as Schœnbein* has stated, so long ago as 1862, that he found traces of ammonia in all the samples of oil of vitriol which he had tested for that substance. My experiments would nevertheless seem to be worthy of publication, both because they confirm Schœnbein's statement and because they go to show that ammonia is far more generally distributed as an impurity of chemical substances than has been commonly supposed hitherto.

The following acids were examined quantitatively by distilling a small portion of each of them with milk of lime, free from ammonia, and applying Nessler's reagent to the distillate, in the manner described by Wanklyn, in his "Water-Analysis," London, 1874.

I. Oil of vitriol from a carboy bought at Bay-Side Alkali Works, South Boston.

II. Oil of vitriol from the Chemical Works at North Billerica, Mass.

* Wagner's Jahresbericht Chem. Technologie, viii, 266.

III. Oil of vitriol from Eaton's Chemical Works, South Wilmington, Mass.
IV. Oil of vitriol, "chemically pure," from Trommsdorff of Erfurt.
V. Pan acid from the Works at North Billerica.
VI. Pan acid from Eaton's Works.
VII. Chamber acid from Eaton's Works.
VIII. Chamber acid from the Works at North Billerica.
IX. Chamber acid from the Merrimack Print Works at Lowell.

Five cubic centimeters* of the acid	Gave grams of ammonia (NH_3).
No. I	0·000150
" II	0·000075
" III	0·000245
" IV	0·000095
" V	0·000070
" VI	0·000140
" VII	0·000050
" VIII	0·000158
" IX	0·000090

Care was taken to procure the above samples of acids (excepting Nos. I and IV) directly from the works where they were made. Each of the specimens was kept in a full and tightly closed glass stoppered bottle until tested, and the portion tested was taken from the middle of the bottle. With the exception of Trommsdorff's acid (No. 4) all the samples are known to have been made from sulphur, i. e., not from pyrites. Several other samples of oil of vitriol of unknown origin were found to contain ammonia when tested qualitatively with Nessler's reagent, and with the even more delicate reagent of Einbrodt.† So too when applied, for the sake of control, to the distillate from acid No. 4 of the foregoing list, Einbrodt's test gave a very strong reaction for ammonia.

There are several ways in which sulphuric acid may be contaminated with ammonia. Some insignificant traces of this substance are of course contained in the air which is used for making the acid, and a still larger amount is often contained in the water that plays so important a part in the process of manufacture. It is not impossible indeed that nitrogen compounds in the water may sometimes be the cause of appreciable traces of ammonia in the acid. It is easy to conceive moreover that considerable quantities of ammonia may be formed in the apparatus of the sulphuric acid maker through reduction of nitric acid or other oxide of nitrogen that is necessarily present,

* The weight of 5 c. c. of the oil of vitriol was rather more than 9 grams in each instance; that of the pan acid was about 8¼ grams, and that of the chamber acid rather more than 7 grams.

† Mercuric chloride in alkaline solutions. See Liebig & Kopp's Jahresbericht, 1852, v, 723 and 1863, xvi, 167.

and I find, in fact, by direct experiment, that ammonia is formed when warm dilute nitric acid is made to act upon lead or upon sulphur.

Action of dilute Nitric Acid on Lead.—A quantity of soft, clean commercial lead that had just been remelted was placed in a small glass flask and 50 c. c. of dilute nitric acid (sp. gr. 1·15) were poured upon it. The flask was closed against the air with a gas delivery tube, and after the action of the acid had ceased the solution was boiled with the milk of lime and the distillate tested for ammonia. But the reaction with Nessler's liquor was so strong that no estimation of the amount of ammonia could be made. A quantity of the lead (30 grams) boiled by itself in the milk of lime gave a distillate in which no ammonia could be detected by the Nessler test. On the other hand, 50 c. c. of the dilute nitric acid were found to contain 0·000025 gram of ammonia.

In a second trial 50 grams of the commercial lead were warmed during three hours with 50 c. c. of the dilute nitric acid The solution was distilled with the milk of lime and the ammonia in the distillate was estimated by titration with standard oxalic acid:—0·002483 gram of ammonia was found.

In a third trial 25 grams of pure lead (from Marquart of Bonn,) were warmed with 50 c. c. of the dilute nitric acid and 0·008279 gram of ammonia was found in the solution of nitrate of lead.

Action of dilute Nitric Acid on Copper.—15 grams of clean copper clippings were gently warmed with 50 c. c. of the dilute nitric acid until there was no more action. The solution was distilled with milk of lime, and the ammonia estimated by Nessler's test. 0·00004 gram of ammonia was found.

Action of dilute Nitric Acid on Sulphur. 20 grams of powdered brimstone were added to 50 c. c. of the dilute nitric acid and the mixture was maintained at or near the temperature of boiling for three hours. On testing the liquid an abundance of ammonia was found.

In another trial, 20 grams of the powdered brimstone were mixed with *100* c. c. of the dilute nitric acid. The mixture was allowed to stand in the cold for 48 hours, and then boiled gently during 8 hours. On testing the liquor by the Nessler process 0·00225 gram of ammonia was found in it.

A small amount of nitrogen oxides may perhaps be reduced to ammonia in the process of sulphuric acid making by other deoxidizing agents, such as the organic impurities of crude sulphur,* or sulphuretted hydrogen,† or even by sulphurous acid, though in a single experiment in which sulphurous acid,

* See Wagner's Jahresbericht Chem. Technologie, x, 149.

† Compare Johnston, in Gmelin's Handbook, ii, 396.

ved from copper clippings, was passed into dilute nitric (sp. gr. 1·15) for a couple of hours no ammonia could be cted in the liquid. The experiment of Schœnbein* more· is to be remembered, in which ammonia, as well as hurous and sulphuric acids, was detected in water above ɔh sulphur had been burned in the air. It would seem to ɔlain, however, that the substances previously mentioned t usually be the most efficient agents for the production of ammonia.

oubtless a good deal of the ammonia thus formed by reduc- is destroyed again by reacting upon oxides of nitrogen in liquid during the process of concentrating the weak sul- ric acid. Pelouze proposed long ago† to free the acid from ɔus contaminations by heating it with sulphate of ammonia. reaction, though efficient, is simply incomplete.

he presence of ammonia in sulphuric acid having been ʳed, the question presents itself whether, in spite of the lency of ammonia to change to nitrous and nitric acid ugh oxidation, traces of it may not occur in a great variety ie chemicals in whose preparation sulphuric acid takes part. following list comprises several substances, chosen some- t at random, which I have caused to be tested for ammonia, e of them for the sake of proving this idea, though mostly a different purpose. The substances under examination ɜ boiled with milk of lime that had been proved in each in- ce to be free from any trace of ammonia by long continued ing, and testing of the distillates obtained from it. The dis- tes obtained after the addition of the substance to the lime ɜ received in graduated tubes and tested successively with ɜler's reagent until they ceased to show any coloration.

	100 grams (or c. c.) of the substance contained gram of NH_3.
ic acid, taken from a carboy of pure acid from Bay- ɫe Alkali Works, 10 c. c. gave 0·000035 gram of am- onia (NH_3).	0·00035
ɔrhydric acid, the ordinary concentrated commercial ɨid, 10 c. c. gave 0·000015 gram of ammonia,	0·00015
o from a carboy of pure acid from Bayside Alkali ʳorks, 10 c. c. gave very little ammonia,	still less than the preced- ing.
tic acid, chemically pure, from C. White & Co., hiladelphia, 10 c. c. gave no reaction for ammonia,	0·00000
ɪsh alum, pure from Marquart of Bonn, gave strong action for ammonia,	much.
o, pure from Trommsdorff, gave strong smell of am- onia when heated with lime. There was so much nmonia that it could not be estimated by the Nessler st, when 10 grams of the alum were operated upon,	much.

* Journ. prakt. Chemie, lxxxvi, 145. † Gmelin's Handbook, ii, 183.

	100 grams (or c. c.) of the substance contained gram of NH_3.
Sulphate of alumina, pure from Marquart, 20 grams gave too much ammonia to be measured by the Nessler process (as used by us), and so did 5 grams,	much.
Sulphate of iron (ferrous sulphate), 5 grams purified, from Powers & Weightman of Philadelphia, gave 0·00062 gram of ammonia,	0·01240
Ditto, common copperas, the last of an apothecary's barrel, 5 grams gave 0·00507 gram of ammonia,	0·10140
Ditto, copperas of unknown origin taken from a bottle in store room of Bussey Laboratory, 100 grams gave only 0·00053 gram of ammonia,	0·00053
Ditto, a sample of pure sulphate of iron from Marquart, gave a strong reaction for ammonia when tested qualitatively, and a reaction was obtained also from a sample of Marquart's sulphate ("pure by alcohol,")	
Sulphate of lime, pure precipitated, from Marquart, 35 grams gave 0·0002 gram of ammonia,	0·00057
Other samples of sulphate of lime, tested in a slightly different way, gave the following results:—545 grams of ground gypsum, obtained originally at a seed store but kept in a store-room of the Bussey Institution for a year or more, were percolated with pure water (two liters) until no reaction for ammonia could be detected and the percolate was boiled without addition of lime, 0·00392 gram of ammonia was found in the distillate. On adding lime a new portion of ammonia equal to 0·00008 was given off,	0·000734
20 grams of ground gypsum bought at a seed store and tested immediately on reaching the laboratory, gave 0·00003 gram of ammonia on being boiled in pure water, and no more ammonia came off on adding milk of lime,	0·00015
150 grams of plaster of Paris, taken from a box in the Bussey store-room, gave 0·0035 gram of ammonia on being boiled with water alone, and 0·00002 gram more of ammonia came off on boiling with lime,	0·00234
20 grams of plaster of Paris taken from a keg found standing in a recently built house, gave 0·000035 gram of ammonia on being boiled with water alone,	0·000175+
Sulphate of potash, chemically pure, from Trommsdorff, 20 grams gave only a faint trace of ammonia,	trace.
Sulphate of soda, chemically pure crystals from Marquart, 20 grams gave no trace of ammonia. This result was verified by many qualitative trials,	0·00000
Bisulphate of soda from Marquart, gave strong reaction for ammonia when tested qualitatively,	much.
Sulphate of copper, pure from Marquart, 10 grams gave 0·000105 gram of ammonia,	0·00105

	100 grams (or c. c.) of the substance contained gram of NH_3.
Nitrate of potash, pure crystals from Marquart, 20 grams gave 0·000015 gram of ammonia,	0·000075
Nitrate of soda, taken from a bag of the crude nitrate of commerce, 20 grams gave 0·00004 gram of ammonia,	0·00020
Common salt taken from middle of a large lump of native rock salt bought at a grocer's shop, 20 grams gave 0·000022 gram of ammonia. Compare Vogel's detection of chloride of ammonium in rock salt (Gmelin's Hand-book, ii, 416),	0·00011
Ditto, pure from Marquart, 20 grams gave 0·0000425 gram of ammonia,	0·000213
Ditto, a sample prepared by dissolving pure crystals of carbonate of soda in pure chlorhydric acid gave no reaction when tested directly with Nessler's reagent,	none.
Phosphate of soda, pure crystals from Marquart, 20 grams gave no reaction for ammonia,	0·00000
Acetate of soda, pure crystals, 20 grams gave no reaction for ammonia,	0·00000
Carbonate of soda, pure crystals from Marquart, gave no reaction for ammonia when tested directly with Nessler's reagent,	0·00000
Carbonate of potash, pure from Marquart, gave no reaction when tested directly,	0·00000
Hydrate of soda, pure from Marquart, 5 grams gave no reaction for ammonia,	0·00000
Hydrate of lime, obtained by slacking the excellent quicklime from Brandon, Vt., 20 grams of the whitest portion of the mass gave no reaction for ammonia, while 20 grams of the grayest portion gave 0·00001 gram of ammonia,	0·00005
Chlorate of potash from Marquart gave 0·0001 gram of ammonia,	0·00050
Crude sulphur, from a box in Bussey store-room, 10 grams gave 0·00015 gram of ammonia,	0·00150
Flowers of sulphur from Marquart, 10 grams gave 0·00075 gram of ammonia,	0·00750
Sulphide of sodium from Marquart, 5 grams gave 0·001 gram of ammonia,	0·02000
Sulphide of potassium from Marquart, 5 grams gave 0·0009 gram ammonia,	0·01800
Sulphide of iron from Marquart, 5 grams gave 0·00085 gram of ammonia,	0·01700
Ditto, from a quantity of the foregoing that had just been fused in a Hessian crucible, 20 grams taken from the middle of the solid cake, gave 0·00025 gram of ammonia,	0·00125

Portions of the distillates from the sulphides of sodium, potassium and iron, on being tested with Einbrodt's reagent, for the sake of control, gave strong reactions for ammonia.

In order to avoid any confusion that might arise from coloration of the Nessler reagent by sulphuretted hydrogen, the following modifications of the ordinary process were employed in testing sulphur and the sulphides. In the case of sulphide of potassium and sulphide of sodium, the weighed substance was dissolved in about half a litre of pure water, free from ammonia, the solution was distilled and a quarter litre of distillate was collected, experience having shown that all the ammonia in the sulphide came forward in this amount of liquid. The distillate was acidified with a few drops of sulphuric acid, boiled until sulphuretted hydrogen had ceased to come off and then redistilled with milk of lime, the ammonia in the new distillate being determined with Nessler's reagent in the usual way.

In the case of sulphur and sulphide of iron the finely powdered, weighed substance was distilled with milk of lime, the distillate was acidified and boiled to expel sulphuretted hydrogen and finally redistilled in the manner just described.

Oxalic acid, "tertium depuratum" from Marquart, 20 grams gave 0·0003 gram of ammonia,	0·00150
Tartaric acid, from Marquart, 10 grams gave 0·0001 gram of ammonia,	0·00100
Vogel (Wagner's Jahresbericht, ix, 526) found 0·012 per cent of ammonia in a sample of crude tartar,	0·01200
Boracic acid, pure from Marquart, 10 grams gave 0·000055 gram of ammonia,	0·00055;

that is to say, rather less than might have been inferred from the fact that ammonium compounds accompany boracic acid in the Tuscan lagoons (see Gmelin's Handbook, ii, pp. 97. 98; Bechi, Wagner's Jahresbericht, ix, 355; Vohl, ibid. xii, 205, and ibid. (N. S.) i, 210.)

Though the figures in the foregoing table may seem small or even insignificant to persons unaccustomed to use Nessler's test, they are really large in several instances and noteworthy in all. It should be understood, moreover, that in working with Nessler's process it is easy to exclude ammonia from the water and from the other reagents that are employed and to avoid the ammonia of the air. It is hardly necessary to urge that the utmost care has been exercised in these respects in all the foregoing tests. A large proportion of the substances tested were taken from the tightly closed, particularly well ground, glass-stoppered bottles in which they had been imported and which had never been opened until the time of applying the test, but it is noteworthy that this precaution seemed to be devoid of significance.

Those substances, such as sulphate of soda for example, which contained no ammonia when taken from freshly opened bottles, likewise contained none when taken from bottles that had been frequently opened and which had stood in a store-room with other chemicals during three or four years. I find naturally enough, that filter paper and other porous materials that have been exposed to the air of a laboratory are highly charged with ammonia, in the same way that the reagent bottles upon our shelves become coated with ammonium compounds, but it would seem, nevertheless, that there is a limit to the penetrative power of the ammoniacal gases. It will be noticed for that matter that a tolerably large proportion of the substances examined contained no ammonia whatsoever, and in general I have not observed that chemicals taken from their bottles at the moment of reaching the laboratory are any more liable to be free from ammonia than those which have been long in store.

A good idea of the relative importance of the ammonia found in the chemicals above described may be got by contrasting the figures given in the table with the amounts of ammonia that occur in natural waters as given by Wanklyn and by many other authorities, or by comparing the above results obtained from chemicals with the following statement of results that were obtained from rain water in this laboratory at the same time and by the same operator.

	Contained milligrams of Free NH^3.	Contained milligrams of Albumenoid ammonia.	100 c. c. of the water contained grams free NH^3.
One litre of rain water taken from south cistern of Bussey Inst.			
April 20, 1875,	·532	·08	0·0000532
April 20, 1875,	·532	·06	0·0000532
April 22, 1875,	·480	....	0·000048
May 4, 1875,	·500	·10	0·00005
June 7, 1875,	·480	....	0·000048
June 7, 1875,	·475	....	0·0000475
One litre of rain water caught in dish on roof of Bussey Inst.			
July 23, 1875,	·100	....	0·00001
July 29, 1875,	·300	....	0·00003
One litre of rain water from snow caught			
April 20, 1875,	·147	·06	0·0000147

It is worthy of mention that water obtained by melting ice —such as sold hereabouts, as in all American towns, for domestic use—is remarkably free from ammonia. Thus a litre of water obtained by melting a block of Muddy Pond ice was found to contain only ·013 milligram of ammonia. In other words, 100 c. c. *of the melted* ice contained no more than

0·0000013 gram of ammonia. A litre of water obtained by melting the clear portion of a block of Jamaica Pond ice, contained ·04 milligram of ammonia, and a litre of water obtained by melting the cloudy porous portion of the same block yielded precisely the same amount, viz: at the rate of 0·000004 gram of ammonia in 100 c. c. of the water. By distilling off from a glass vessel a comparatively small proportion of the melted ice it is easy to expel these traces of ammonia and to obtain water that is practically free from that substance, such as is needed for making the standards of comparison upon which the Nessler test depends. It appeared in fact that before such distillation the mere melted ice was as free from ammonia as the water of deep wells in this neighborhood, that had been slowly boiled down in a copper still to four-fifths of its original volume for the express purpose of expelling ammonia. Both the melted ice and the purified well waters had to be distilled anew in glass vessels in order to obtain water that was completely free from ammonia, but the proportion of impure distillate to be thrown aside was no larger in the one case than in the other.

I am indebted to my assistant, Mr. D. S. Lewis, for his skillful coöperation in this research, and to my friend Mr. F. P. Pearson, chemist of the Merrimack Print Works, for a number of samples of acids.

Bussey Institution, Jamaica Plain, Mass., September, 1875.

ART. LIV.—*Abstract of a Memoir on the Origin of the Alps*; by Prof. EDWARD SUESS, of Vienna.*

ACCORDING to the views of the early geologists, still widely accepted, the origin of mountains is to be ascribed to the elevation of a molten or semi-molten mass which has thrown up the rocks along its axis, and crowded the upper strata to the right and left, forming in this way a mountain-chain. This principle has been applied to the Alps by Studer, and, in accordance with this it has been customary to speak of a middle zone, embracing the isolated central masses, with parallel subordinate zones to the north and south. The folding and banded arrangement in the outer chains has been ascribed to a mighty pressure which has been exerted in a northerly or southerly direction by the central zone, as it was elevated from below. The cause of the elevation has been left entirely unexplained.

This view is, however, at variance with all the facts observed. It may be true that the granites of the Alps are in great measure of eruptive origin; but they are unquestionably much

* Die Entstehung der Alpen, 168 pp. 8vo. Wien, 1875.

older than the Molasse of Lucerne, so that they can have had no influence in the dynamic changes in which it has been involved; moreover, with the exception of one or two unimportant cases, no example can be shown in which eruptive rocks have been the cause of change of position in the older sedimentary strata. Another argument against this view is found in the irregular, shattered condition of the central masses as contrasted with the even trend in the folds of the outer-lying mountain chains. A glance, for instance, at the position of the crystalline rocks of the Finsteraarhorn, overlying the younger strata, shows that the folding-over must have originated, not in the eruption or expansion of isolated central masses, but in some general, horizontal movement of the mountain-system as a whole.

In the general consideration of this subject it is to be explained that the term Alpine System is intended to include all the mountain chains, with their various branches, from the Jura Mountains to the Appenines in the south, and the Carpathians in the east—in other words all those mountains which show a constant predominance of certain trends or lines of directions. The western and northern limits of this extended region are formed by the older elevations of the Iles d'Hières, the eastern edge of the Central-Plateau of France, the southern extremities, of the Vosges Mountains and the Black Forest, with the southern border of Bohemia. Within this limit, the Alps are developed with wonderful regularity, stretching in great curves from the end of one of these older mountain points to the next; and against them the rocks have been pressed up and shoved on in parallel lines, as against immovable barriers. An example of this action is furnished by the island of gneiss and *rothliegendes* at Dôle, which forms the southeastern continuation of the Vosges Mountains, where the dependence of the folds and fractures in the Jura on the distribution of the older rocks can be most clearly seen. The whole Jura Mountains have been here pressed up into many parallel bands, while on the other side of the obstruction the Jurassic deposits cover a wide area without showing any trace of this tremendous horizontal movement. This same principle is true of the Alps to the east, but it is to be noticed that in the Juras the rocks in the northern border are continued immediately beyond the limits of the mountains, while in the eastern Alps the rocks, which on the northern side tower over the plain, have as a rule no distinct continuation on the other side of it.

Again, each branch of the Alpine system is everywhere *one-sided*, not symmetrically formed; while, at the same time, the moving power was alike throughout. This point is especially well exemplified by the Appenines, whose structure deserves a

detailed description. To the north of Genoa the long lines of the Molasse and Flysch rise gradually from the Piedmontese plain, and extend southward in great curves. In the neighborhood of Bologna the Flysch forms the dividing line between the inner-Appenine depressions of Tuscany and the outer-Appenine region of Adria, and it stretches on in an unbroken course through the peninsula to the Gulf of Tarentum. Within this limit the limestone mountains extend uninterrupted from Spezia southward, embracing the Abruzzen, the Gran Sasso and the elevations of the Basilicata. Still within the line, on the western coast of Italy, are found the isolated fragments of the older crystalline rocks. As traces of the action of the mighty forces which caused this great horizontal shove, we may point to the wide areas of depression of the Tyrrhenian and eastern part of the Ligurian seas, while between the ruins of the ancient rocks the fissures are to this day in part open, on which are situated a long series of volcanoes, and along which earthquake shocks are propagated. Thus the Appenines show two sides differing essentially from each other—one the side of shoving and folding, the other of fracture and volcanic phenomena; the former is convex and continuous, the latter is interrupted by areas of depression.

The western Alps repeat the same contrast of a folded outer side, and an inner side of fracture, though here the volcanic mountains are wanting. At no point on the southern side of these western Alps can an equivalent of the long anticlinal of the Molasse be found; in no case can a profile be given which shall show an older middle zone flanked by symmetrical side zones. The Juras, too, are a model of a true one-sided movement, caused by pressure against an immovable foreign mass of older rocks. The fracture line is in this case turned toward the Alps.

The eastern Alps alone show a great series of Mesozoic and Tertiary rocks on their southern side, which might be regarded as belonging to the hypothetical southern zone. If we attempt, however, to compare the long series of regular folds, which are so conspicuous in the northern zone, with the rocks on the other side, we find that nowhere in the latter is there the slightest correspondence. The careful consideration of the relations here exhibited shows that the strata do not conform in strike with those of the northern zone. On the contrary, we are justified in concluding that this broad mountain girdle separates toward the east into several one-sided chains.

The same one-sided structure belongs to the Carpathians and the other branches of the Alpine system to the east and south. This principle established, it becomes clear that we must abandon the idea of a symmetrical structure—a middle zone with

wo equal and corresponding side zones, and grant that the whole mountain-chain, from the Appenines to the Carpathians, s the product of a common force, which has acted more or less n a horizontal direction.

In regard to the age of the Alps, or more properly the epoch n which they were elevated, a somewhat different view must e adopted than that which was accepted in former years. It is now unquestioned that strata belonging to the middle Tertiary have shared in the general movement. This shows that the movements which have ended in the elevation of this chain continued up to a comparatively recent time. It is equally true, however, that the same regions have in much earlier times repeatedly suffered similar movements, as is shown by the position of the younger sediments on the oldest rocks of the same chain. The many examples of this truth which might be quoted how that, up to a time which extends far into the Mesozoic ge, the region of the Alps was often the theater of great catastrophes. The greater abundance of eruptive rocks in the southern Alps shows that in the earlier times the course of action was ssentially the same as in later epochs.

The consideration of all the subjects touched upon in the preceding paragraphs lead to conclusions which to a very considerable extent agree with those arrived at by Prof. Dana in is discussion of mountain-making in general.

The force which acted to produce the results, which we see o-day must have been a *horizontal* one, as is abundantly proved y a survey of all the facts. The exertion of this horizontal orce was essentially influenced by resistance from four different ources: 1, from the presence of foreign masses of older rocks; , from the folding mass itself; 3, from the occasional introducion of older volcanic rocks, as granite and porphyry, in the moving mass; 4, finally, it appears that single mountain masses, ike the Adamello or the red-porphyry, near Botzen, have exerted an essential influence on the development of the surrounding mountain region.

The examination of the various mountain regions of Europe not included in the Alpine system, gives confirmation of the views thus far expressed in regard to the one-sided nature of mountains, and the horizontal shove which has been the cause of their elevation. This is true of the Bohemian region, taken as a whole; of the Riesengebirge, the Erzgebirge, and so on.

[For a detailed discussion of the subject, reference must be made to the complete memoir, of which this is an abstract.]

The direction of the fracture lines varies from northeast to northwest, and the motion was mostly to the northward, though ome isolated exceptions, in the case of a southerly movement,

exist in central Europe. If we look at the subject more broadly, however, and pass out of Europe to America. and then further study in as great detail as is now possible the great mountain-chains of Asia, we arrive at this grand conclusion: throughout, mountain-masses and mountain-movements are *one-sided*, and the direction of the movement is in general *northwest, north, or northeast*, in North America and Europe, but southerly, or southeasterly, in central Asia. There is no regular geometrical arrangement in the mountain chains.

Looking at the facts which have been stated, making only the supposition that an unequal contraction of the surface of the planet has taken place, we see that the simplest form of mountain consists in a fracture, which runs at right angles to the direction of the contraction; the fractured part moves forward in the direction of the force from contraction, while volcanic phenomena may manifest themselves at the line of breakage. The Erzgebirge forms an example of such a mountain-mass.

The second and most common form begins with a main fold striking across the direction of contraction, and inclined toward that. The breakage takes place in the fold in the line of greatest tension. If the force continues, the part of this fold in advance will be pushed still farther on, piling up before it the sedimentary strata into broader, subordinate folds, while the part behind sinks down, and, between its fragments, the volcanic phenomena appear. Thus it is with the Appenines. In case of an obstruction in front the mass may be turned aside, and, in fact, many complications may thus arise.

Still a third form consists in the formation of a large number of parallel folds which cover a considerable area, but with a steep line, as a rule, on the inner side of the fracture, while the volcanic phenomena are wanting. Here belong the Jura Mountains. Cases may also occur in which the width of the main-fold is so great that there results, not a mountain-chain, but a general mass-elevation; an example of this may be found in the recent changes of level observed on the Scandinavian coast.

In regard to the depth at which the contraction producing the lateral pressure took place, it may be safest to say that while in many cases the depth must have been very great, in others the contrary is true. Thus the movement which occasioned the fracture of the Erzgebirge must have taken place at a great depth, as also those which elevated the oldest rocks of the Alps. On the other hand, the shoving forward of the northeastern Alps, and the deviation in their direction, belong to a higher horizon, and the elevation of the Molasse to one still higher, while examples may also be given of foldings which must have been very shallow.

No influence of a radial contraction has been observed; nor is there any effect in the direction of the waves of contraction which can be attributed to the rotation of the earth.

In conclusion, it may be remarked that mountain-making as a whole can be regarded as a stiffening of the earth's surface, which process has been determined by the distribution of certain older rigid masses. These may be made up of mountain lines pushed up together, and crossing each other, as in Bohemia, or they may consist of wide extended surfaces whose strata, even the oldest, have retained their horizontal position, as in the great Russian plain. These primitive masses conform to no geometrical law either in outline or distribution, though they have determined the form and course of the folds which contraction has produced in the more pliant portions of the earth's surface between them. E. S. DANA.

ART. LV.—*Studies on Magnetic Distribution*; by HENRY A. ROWLAND, of the Johns Hopkins University, Baltimore.

(Continued from page 335.)

Table I. is from a bar 17½ inches long with a magnetizing helix 1½ inch long at one end, the zero-point being at the other. Table II. is from a bar 9 feet long with a helix 4½ inches long quite near one end, the zero-point being at 1 inch from the helix toward the long end. Table III. is from a bar 2 feet long with a helix 4½ inches long near one end, so that its center was 19¾ inches from the end on which the experiments were made, the zero-point being at the end.

TABLE I. Bar ·18 inch diameter. 0 at end of bar.

L.	Q'_ε. Observed.	Q'_ε. Calculated.	Error of Q'_ε.	Q'. Observed.	Q'. Calculated.	Error of Q'.
0	2·7	....	....	0	0·	0
3	3·2	....	....	2·7	3·5	+ ·8
5	2·0	2·0	0	5·9	6·6	+ ·7
6	2·5	2·4	− ·1	7·9	8.6	+ ·7
7	3·2	2·8	− ·4	10·4	11·0	+ ·6
8	2·7	3·5	− ·2	13·6	13·8	+ ·2
9	4·3	4·3	0	17·3	17·3	0
10	5·3	5·2	− ·1	21·6	21·6	0
11	6·5	6·5	0	26·9	26·8	− ·1
12	7·7	8·0	+ ·3	33·4	33·3	− ·1
13	9·5	9·9	+ ·4	41·1	41·3	+ ·2
14				50·6	51·2	+ ·6

$Q' = 2{\cdot}60(\varepsilon^{\cdot 213L} - \varepsilon^{-\cdot 213L})$.

$Q'_\varepsilon = r2{\cdot}60(\varepsilon^{\cdot 213L} + \varepsilon^{-\cdot 213L}) = {\cdot}554(\varepsilon^{\cdot 213L} + \varepsilon^{-\cdot 213L})$.

In adapting the formula to apply to the case of Table I, we may assume that at the end of the bar $s = \infty$ and $C = 0$, which is equivalent to assuming that the number of lines of induction which pass out at the end of the rod are too small to be appreciated.

In Table II. observations were not made over the whole length of the rod, and the zero-point was not at the end of the bar. It is evident, however, that by giving a proper value to s we may suppose the bar to end at any point. As the rod is very long, expressions of the form

$$Q' - C'' = C'\epsilon^{-rL} - C'' \text{ and } Q'_{\epsilon} = rC'\epsilon^{-rL}$$

will apply.

TABLE II. Bar ·39 inch diameter. 0 at 1 inch from helix.

L.	Q'_{ϵ}. Observed.	Q'_{ϵ}. Calculated.	Error of Q'_{ϵ}.	$Q'-C''$. Observed.	$Q'-C''$. Calculated.	Error of Q'.
0	----	----	----	....	902·5	
1	71·7	70·8	− ·9	825·2	825·9	+ ·7
2	65·2	65·3	+ ·1	753·5	755·1	+1·6
3	59·5	60·2	+ ·7	688·3	689·8	+1·5
4	53·5	55·5	+2·0	628·8	629·5	+ ·7
5	51·2	51·2	0	575·3	574·3	−1·0
6	46·7	47·2	+ ·5	524·1	523·1	−1·0
7	43·2	43·5	+ ·3	477·4	476·0	−1·4
8	40·0	40·1	+ ·1	434·2	432·5	−1·7
9	37·2	37·0	− ·2	394·2	392·5	−1·7
10	34·7	34·1	·6	357·0	355·6	1·4
11	31·7	31·4	− ·3	322·3	321·5	·8
12	29·5	28·9	− ·6	290·6	290·1	·5
13	25·7	26·6	+ ·9	261·1	261·2	+ ·1
14	25·5	24·6	− ·9	235·4	235·5	·1
15	22·0	22·7	+ ·7	210·9	210·0	+ ·1
16	21·5	20·9	− ·6	187·9	187·3	·6
17	20·0	19·3	− ·7	166·4	166·4	0
18	19·1	17·8	1·3	146·4	147·1	+ ·7
19	32·5	31·5	−1·0	127·3	129·4	+2·1
21	27·5	26·7	·8	94·8	97·8	+3·0
23	23·0	22·8	− ·2	67·3	71·1	+3·8
25	18·5	19·4	+ ·9	44·3	48·6	+4·3
27	14·5	16·5	+2·0	25·8	23·0	+ 2
29	11·3	14·0	+2·7	11·3	12·6	+1·3
31				0	−1·2	[illegible]

$$Q' - C'' = 983\epsilon^{-\cdot 08135L} - 80\cdot 6 = 983(10)^{-\cdot 0354L} - 80\cdot 5.$$

$$Q'_{\epsilon} = r983\epsilon^{-\cdot 08135L}\Delta L = 80(10)^{-\cdot 03531}\Delta L.$$

In Table II. the observations were near the end of the rod, and were repeated several times. Neglecting the end of the rod we have $s = \infty$.

In these tables we see quite a good agreement between theory and observation; but on more careful examination we observe a certain law in the distribution of errors. Thus in Table I. the

TABLE III. Bar ·39 inch diameter. 0 at end of bar.

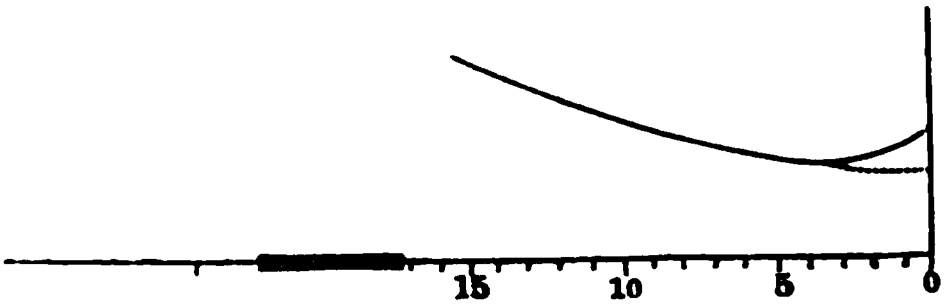
L.	Q'_t. Observed.	Q'_t. Calculated.	Error of Q'_t.	Q'. Observed.	Q'. Calculated.	Error of Q'.
0				0·	0·	0
1	19·7	15·2	−4·5	19·7	15·2	−4·5
2	16·3	15·3	−1·0	36·0	30·5	−5·5
3	16·0	15·5	− ·5	52·0	46·0	−6·0
4	15·8	15·9	+ ·1	67·8	61·8	−6·0
5	16·5	16·3	− ·2	84·3	78·1	−6·3
6	17·0	16·9	− ·1	101·3	95·0	−6·3
7	17·6	17·6	0	118·9	112·6	−6·3
8	18·4	18·4	0	137·3	130·9	−6·4
9	19·2	19·4	+ ·2	156·5	150·3	−6·2
10	20·3	20·5	+ ·2	176·8	170·7	−6·1
11	21·8	21·7	− ·1	198·6	192·2	−6·4
12	22·8	23·1	+ ·3	221·4	215·3	−6·1
13	24·8	24·7	− ·1	246·2	239·9	−6·3
14	26·8	26·5	− ·3	273·0	266·4	−6·6
15	28·8	28·4	− ·5	301·8	294·6	−7.2
16	31·8	30·5	−1·3	333·6	325·1	−8·5

$Q'_t = 7{\cdot}6(10^{{\cdot}037L} + 10^{-{\cdot}037L})$; $Q' = 89(10^{{\cdot}037L} - 10^{-{\cdot}037L})$.

ors of Q' are all positive between 0 and 8 inches; and this s always been found to be the case at this part of the bar in my experiments.

The explanation of this is very simple. In obtaining the mulæ we assumed that the magnetic permeability of the bar was a constant quantity; but it has been shown by Dr. pletow and myself, independently of each other, that μ in- eases as the magnetism of the bar increases when the latter is t great. Hence between 0 and 8 inches the resistance of the r R is greater than at succeeding points, and hence a less mber of lines of induction pass down the bar from 8 towards than would be given by the formula which has been adapted the average value of R at from 9 to 14 inches. In Table this same fact shows itself towards the last of the table, d would probably be more prominent had the table been rried further. However, in this table all things have com- ned to satisfy the formula with great accuracy.

2.



Distribution at end of bar.

In Table III. we come across a fact of an entirely different ture from the above. Fig. 2 is the plot of this table, and ves the *values of Q'^t at* different parts of the rod.

The horizontal line in the figure represents values of L, and the vertical ordinates are values of Q'_e. The full line gives the observed distribution, and the dotted line that according to the formula.

The formula gives the distribution very nearly for all points except those near the end. The formula indicates that Q'_e decreases continully toward the end; but by experiment we see that it increases near this point. On first seeing this, I thought that it was due to some residual magnetism in the bar; but after repeating the experiment several times with proper care, I soon found that this was always the case. I give the following explanation of it:—In the formulæ we have assumed R′, the resistance of the medium, to be a constant; now this resistance includes that of the lines of force as they pass from the rod through the medium and thus back to the other end of the rod; and of this whole quantity the part which affects the relative distribution at any part of the rod most is that of the medium immediately surrounding that part; and so the parts near the end have the advantage over those further back, inasmuch as the lines can pass forward as well as outward into the medium. The same thing takes place in the case of the distribution of electricity, where the "density" is inversely proportional to the resistance which the lines of inductive force experience from the medium; and here we find that the "density" is greatest on the projections of the body, showing that the resistance to the lines of induction is less in such situations, and by analogy showing that this must also be the case for lines of magnetic force. But this effect is not very great in cylinders until quite near the end; for Coulomb, in a long electrified cylinder, has found the density at one diameter back from the end only 1·25 times that at the center, and so there is probably a long distance in the center where the density is sensibly constant. Hence we may suppose that our second hypothesis that R′ is a constant will be approximately correct for all parts of a bar except the ends, though of course this will vary to some extent with the distribution of the lines in the medium; at least the change in R′ will be gradual except near the end, and so may be partially allowed for by giving a mean value to r.

Hence we see that could the formula be so changed as to include both the variation of R and of R′, it would probably agree with the three tables given.

To study the effect of variation in the permeability more carefully, we can proceed in another manner, and use the formulæ only to get the value of r at different parts of the rods.

No matter how r may vary, equations (2) and (3) will apply to a very small distance l along the rod; and as the origin of coordinates may be at any point on the rod, if Q′ and Q'_e are

taken at one point and Q and Q_t at another point whose distance from the first is l, we shall have the four equations

$$Q = C, \qquad Q' = \frac{C}{A+1}(A\varepsilon^{rl}+\varepsilon^{-rl}),$$

$$Q_t = \frac{A-1}{A+1}Crl, \qquad Q'_t = rl\frac{C}{A+1}(A\varepsilon^{rl}+\varepsilon^{-rl}).$$

Calling $\frac{}{Q} = H$ and $\frac{Q'}{Q} = G$, we shall find, on eliminating C and A and developing ε^{rl} and ε^{-rl},

$$r^2 = \frac{2}{l^2}\left(\frac{GH+1}{G+H}-1\right); \quad . \quad . \quad . \quad . \quad . \quad . \qquad (9)$$

or to a greater degree of approximation,

$$r^2 = \frac{1}{l^2}\left(\sqrt{12\left(2\frac{GH+1}{G+H}+1\right)}-6\right). \quad . \quad . \quad . \quad . \qquad (9a)$$

Before applying these formulæ to any series of observations, the latter should be freed from most of the irregularities due to accidental causes. For this purpose the following Tables have been plotted and a *regular* curve drawn to represent as nearly as possible the observations; in other cases a column of differences was formed and plotted. In either case the ordinates of the curves were accepted as the true quantities. But for fear that some may accuse me of tampering with my observations, I have in all cases added these as they were obtained

The correction is necessary, because small irregularities in the observations will produce immense charges in r^2.

Table IV. contains some of the best observations I have obtained. It is from a bar 57 inches long with a helix $1\frac{1}{2}$ inch long in the center to magnetize it. Each quantity is the mean of six observations, these being made on both ends of the bar and with the current in opposite directions.

In this table a source of error was guarded against which I have not seen mentioned elsewhere. When a bar of iron is magnetized at any part and the distribution over the rest quickly measured, on being then allowed to stand some time and the distribution again taken, it will have changed somewhat, the magnetism having, as it were, creeped down the bar further. Hence in this table time was allowed for the bar to reach its permanent state.

On looking over column 6, which contains the values of $\frac{1}{r^2} = \frac{R'}{R} = R'\alpha\mu$ (equation 7), we observe that as Q' increases, the value of $R'\alpha\mu$ first increases and then decreases. Now it is not probable that R' undergoes any sudden change of this sort,

TABLE IV. Bar ·19 inch diameter. 0 at center of bar.

L.	Q'_s. Observed.	Q'_c. Corrected.	Q'. Corrected.	$r^2=\frac{R}{R'}$	$\frac{1}{r^2}=\frac{R'}{R}$
1			151·7		
2	24·0	24·0	127·7		
3	17·0	17·0	110·7	·041	24·4
4	13·7	13·7	97·0	·0256	39·1
5	11·6	11·65	85·4	·0192	52·1
6	10·2	10·15	75·2	·0168	59·6
7	9·0	9·0	66·2	·0150	66·7
8	8·0	8·0	58·2	·0153	70·4
9	7·1	7·15	51·1	·0150	66·7
10	6·4	6·35	44·7	·0142	62·9
11	5·7	5·65	39·1	·0160	62·5
12	4·9	5·0	34·1	·0167	59·9
13	4·4	4·4	29·7	·0180	55·6
14	3·6	3·9	25·8	·0184	54·3
15	3·3	3·4	22·4	·0184	54·2
28½	22·4	22·4			

and so it is probably due to change in the permeability of the rod. Hence by this method we arrive at the same results as by a more direct and exact method.* But by this means we are able to prove in the most unequivocal manner that *magnetic permeability is a function of the magnetization of the iron and not of the magnetizing force.* Hence it is for this reason that I have preferred in my papers on "Magnetic Permeability" to consider it in this way in the formulæ and also in the plots, while Dr. Stoletow in his paper (Phil. Mag., Jan., 1873) plots the magnetizing-function as a function of the magnetizing-force.

When we plot the results in this table with reference to Q' and $R' \propto \mu$, the effect of the variation of R' is apparent: and we see, on comparing the curve with those given in my paper above referred to, that R' increases as L increases, at least between L = 2 and L = 8, which is as we should suppose, from the arrangement of the apparatus. For this table I happen to have data for determining Q in absolute measure, and these show that the maximum value of μ should be about where the table shows it to be.

This method of finding the variation of μ is analogous to that of finding conductivity for heat by raising the temperature of one end of a bar and noting the distribution of heat over the bar: and indeed the curves of distribution are nearly the same in the two cases.

If it were thought worth while, it would be very easy to obtain a curve of magnetic distribution for a rod and then enclose the whole rod in a helix and determine its curve of permeability.

* Phil. Mag., August, 1873.

; would give data for determining R′ in absolute measure at y point of the rod.

o complete the argument that the variation of r^2 is in great sure due to that of μ, I have caused the magnetizing-force bar to vary. Tables V, VI, and VII. are from a bar 9

TABLE V. Magnetizing current ·176.

L.	Q'_ϵ. Observed.	Q'_ϵ. Corrected.	Q'. Corrected.	$r^2=\frac{R}{R'}$.	$\frac{1}{r^2}=\frac{R'}{R}$.	Q'_ϵ. Calculated.
0	2·7					0
1	6·9					2·40
2	12·7	----	----	----	----	7·32
3	18·2	----	----	----	----	12·54
4	24·4	----	----	----	----	18·31
5	32·4	31·7	220·5	----	----	24·87
6	31·5	32·0	188·5	·0190	52·4	32·38
7	28·2	28·2	160·3	0212	47·2	$Q'_\epsilon=3{\cdot}34(10^{\cdot 08(l-x)}-10^{\cdot 08x})$.
8	24·9	24·7	135·6	·0218	45·9	
9	21·4	21·7	113·9	·0236	42·4	
10	18·6	19·0	94·9	·0252	39·7	
11	16·8	16·4	78·5	·0298	36·0	
12	14·2	14·2	64·3	·0311	32·2	
13	12·0	12·0	52·3	·0367	27·2	
14		10·0	42·3	·0404	24·8	
15	17·7	8·2	34·1	·0440	22·7	
16		6·6	27·5	·0445	22·5	
17	11·6	5·1	22·4	·0570	17·5	
18		22·4				
End.	22·4					

TABLE VI. Magnetizing current ·31.

L.	Q'_ϵ. Observed.	Q'_ϵ. Corrected.	Q'. Corrected.	r^2.	$\frac{1}{r^2}$.	Q'_ϵ. Calculated.
0	16.3					0
2	22·0					17·3
3	32·4	----	----	----	----	22·3
4	43·8	----	----	----	----	32·28
5	55·9	----	----	----	----	43·34
6	55·2	----	391·9	----	----	55·90
7	46·8	55·1	336·8			$Q'_\epsilon=7{\cdot}74(10^{\cdot 08(l-x)}-10^{\cdot 08x})$.
8		48·1	288·7	·0204	49·0	
9	81·3	42·3	246·4	·0201	49·7	
10		37·4	209·0	·0202	49·5	
11	61·8	33·0	176·0	·0220	45·5	
12		29·0	147·0	·0243	41·2	
13	46·4	25·3	121·7	·0262	38·2	
14		21·9	99·8	·0300	33·3	
15	35·4	18·7	81·1	·0352	28·4	
16		15·6	65·5	·0405	24·7	
17	22·0	12·7	52·8	·0479	20·9	
18		9·8				
End.	43·0					

feet long and ·25 inch diameter. At the center a single la of fine wire was wound for a distance of 1 foot, and the curr for magnetizing the bar was sent through this. The zero-p was at the center of this helix and at the center of the bar that the observations on the first 6 inches include the par the bar covered by the helix.

The values of Q'_r are the sum of four observations on each of the bar and with the current reversed. The three tables comparable with each other, the same arbitrary unit being u for all.

TABLE VII. Magnetizing current 1·12.

L.	Q'_r. Observed.	Q'_r. Corrected.	Q' Corrected.	r^2.	$\frac{1}{r^2}$.	Q'_r. Calculated.
0	3.5		762·4			0
1	9·4	----	758·9	----	----	6·58
2	15·4	----	749·5	----	----	8·29
3	27·5	----	734·1	----	----	15·78
4	44·3	----	706·6	----	----	26·70
5	66·6	----	662·3	----	----	43·36
6	71·2	71·2	595·7	---	----	69·27
7	59·5	59·7	524·5	·0239	41·8	
8	51·0	51·2	464·8	·0200	50·0	
9	45·2	45·2	413·6	·0162	61·7	$Q'_r = \cdot 357(10$ [illegible] $- 10$ [illegible]$)$
10	40·3	40·2	368·4	·0141	70·9	
11	36·3	36·8	328·1	·0120	83·3	
12	33 3	33 5	291·3	·0107	93 5	
13	30·6	30 5	257 8	0110	90 9	
14	28 1	28 0	227·3	·0116	86·2	
15	25 6	25·4	199 3	·0118	84 7	
16	23 4	22·7	173 9	·0140	71 4	
17	20 0	20·3	151 2	0147	68 0	
18		18 1	130 2	·0161	62 1	
19	34 0	16 0	112 8	0180	55 6	
20			96 8			
End	96 8					

Here we see an excellent confirmation of the results dedu from Table IV. In Table V, where the magnetizing-force very small, and where, consequently, no part of the iron has reached its minimum resistance, the value of $\frac{1}{r^2} = \frac{R'}{R} = R'$ au creases continually as the value of Q' decreases, as it should In Table VI, with a higher magnetizing-power, which was su cient to bring a portion of the bar to about the minimum res ance, we see that $\frac{1}{r^2}$ remains nearly stationary for a short tance from the helix and then decreases in value. In Table V where the bar is highly magnetized and the portion near zero-point approaches the maximum of magnetization, $\frac{1}{r^2}$

ıes in value as we pass down the bar, and having reached .aximum at $L=11\frac{3}{4}$ nearly, it decreases. These tables, then, ʳ in the most striking manner the effect of the variation of nagnetic permeability of iron upon the distribution of mag- m.

is evident that these tables also give the data for obtaining ·elative values of R′ at different parts of the bar; but the .ts thus obtained are conflicting, and will need further exper- ıt to obtain accurate results. Where such a small magnet- ; force is used as in Table V. it is almost impossible to n accuracy, and allowance should be made for this in ıcing results from it. The greatest liability to error is of se where the magnetization is small; for any small residual ıetism which the bar may contain will be more apparent , although great care was taken to remove all residual ıetism before use. Besides this there are many other dis- ances from which the higher magnetizing-powers are free.

we accept Green's formula as correct, *these observations give 'ata for determining the magnetizing-function of iron in a ue manner*, for nearly all other methods depend on absolute ;urements of some kind. Thus the least value of r^2 in e IV. for a rod ·19 inch diameter is ·0142, which gives)1132, which in Green's formula (equation 8) gives $\mu=3308$ he greatest permeability of this iron; and this is as nearly ; as we can judge for this kind of iron. It is to be noted Green's formula has been found for the portion of the bar red by the helix, but as seen from my formulæ it will ap- imately apply to all portions, though it would be better to a new formula for each case.

'e shall toward the last resume this subject again, and so ⁊ill leave it for the present.

ıe results which I have now given, and indeed all the lts of this paper, have been deduced not only from the ob- ıtions which I publish, but from very many others; so my Tables may be *considered to represent the average* of a extended series of researches, though they are not really so.

[To be continued.]

. LVI.—*Notes on a New Feature in the "Comstock Lode;"* by G. P. Becker, Ph.D., etc.

HERE is probably no metalliferous vein in the world which **tes a** greater interest than the "Comstock Lode" of Ne- **ı,** whether regarded from a scientific point of view, as the **ıst and richest** argentiferous vein yet discovered, or from an

economical standpoint, as the source for many years past of a immense proportion of the silver, and a considerable fraction of the gold added to the circulation of the world; and the detai of its geological character as developed, therefore acquire a importance not possessed by those of less prominent deposits.

The Virginia Range is a due north and south branch of th Sierra Nevada system of mountains. On the eastern slo of Mt. Davidson, the chief peak of the range, were found t outcroppings of the vein which have been followed somewhat t the north, and a long distance to the south of that mountai and shown to possess a total length of four miles in the gener direction of the Virginia Range. Decidedly the most importa portion of the Lode—that in which the celebrated "Gould an Curry," "Hale and Norcross," "Ophir," "Consolidated Virgini and "California" mines as well as others have been opened—li at the base of Mt. Davidson, and is included within the limi of Virginia City.

It is well known to those who have had occasion to mak themselves familiar with the Comstock lode* that througho that portion of the vein which lies in Virginia City, the west o foot wall is a continuation of Mount Davidson, and consists, li the mass of that mountain, of syenite, while the east wall is porphyry, more nearly described as trachytic greenstone, or pr pylite, with which the country was overflowed during the Te tiary period. The direction of the fissure subsequently filled by the vein matter of the Comstock, was plainly determined by the previously existing surface of contact between the syenite and propylite, which naturally offered less resistance to rupture than the solid mass of either adjoining rock. This is clear from the fact that for over a thousand feet from the surface, only insignificant masses of either rock were found on the side of the vein opposite to that of which they are especially characteristic. So strong was the influence of the direction, both in strike and in dip, given to the fissure by the presence of this comparatively weak surface of contact in the rocky mass, that the fissure extending in both directions away from Mount Davidson into solid propylite, unaccompanied by syenite, retained the strike, (nearly north and south,) and the dip (from 35° to 50°.) of the Virginia portion, almost unaltered.

This very clearly defined influence of the contact surface, was of itself good reason for supposing that the fissure in Virginia must follow the dividing plane between the syenite and propylite to a very considerable depth, and not improbably to one beyond the reach of mining operations. Nevertheless, although the subject has been very wisely left in abeyance by the geologists who

* Vide von Richthofen, "The Comstock Lode, San Francisco, 1865," and "U. S. Geological Exploration of the 40th Parallel," Vol. III.

have publicly discussed the Comstock, it cannot have escaped any of them that the fissure could not indefinitely follow this contact; for the propylite is recognized by them as a volcanic rock which has overflowed the older syenite, and therefore, unless we should make the highly improbable assumption that the syenite, (which in Virginia is plutonic,) the propylite, and the vein matter emanated successively from a single fissure in the earth's crust, a lowest point in the contact between the underlying syenite and the overlying propylite must eventually occur, from which the fissure would naturally descend toward the seat of the force by which it was caused. From the most depressed point in the contact surface, the fissure would pass into the underlying, or syenite rock, and doubtless out of it farther below, into whatever might underlie it in its turn.

From the point where the fissure leaves the contact between the two species of rock, its dip would in all probability be controlled by circumstances very different from those which decided it in the position lying near the croppings; for from the point at which the seismic shock impinged upon the lower surface of the syenite, the fracture must have followed the direction of least resistance, or presumably a straight line, and the shortest line from the point in which the subterranean force encountered the syenite, to the upper surface of that formation: and a moment's thought will serve to show that, apart from local and altogether incalculable irregularities in the lower surface of the rock, this line could continue in even approximately the direction of the present dip, only in case the syenite not only formed a cone above the general level of the country, but filled a vast depression below it as well. The passage of the lode into the syenite would therefore naturally be accompanied by a change in dip, toward the perpendicular.

In May last I made observations, repeated and extended in August, which seem to establish beyond question the hitherto unnoticed fact that the lower workings of the mines in Virginia City, have reached the point at which the fissure passes from the contact surface between the syenite of Mt. Davidson and the country propylite, into the underlying syenite. The depth below the surface at which the change occurs is not very far from 1500 feet.

The details of these observations would scarcely be of general interest away from the Pacific Coast, while the conclusion drawn will probably be considered as amply justified by the following general results of examination, viz: The east wall of the lode in the lower levels (1400–2300 feet) wherever struck between the north end of the "Ophir" and the south end of the "Chollar Potosi," a distance of over a mile, is syenite; that in the three mines, of the eight within these limits, in which for fear of water the East

Clay has not been pierced, good grounds (presence of included syenite and absence of included propylite) exist for believing that the hanging wall is syenite:—that although the east country syenite has been pierced in a number of places, both vertically and horizontally, to a depth of several hundred feet, no other formation has been reached, nor any indication that the limits of this have been approached; on the contrary, this eastern syenite is apparently as solid as Mount Davidson itself:—that wherever the relations between the walls of the fissure have been most completely exposed, the occurrence of syenite on the east wall is accompanied by a very decided increase in the angle of dip.

The last point is most clearly shown in the Ophir, where on the 1700 feet level the walls are almost exactly perpendicular, as shown by the very complete prospecting on that level.

The Gold Hill mines seem nowhere to have reached the syenite, as was to be expected, since from the conformation of the country, the syenite, if it underlies the porphyry in Gold Hill as well as in Virginia, will probably be met with only at a much greater depth.

To establish the exact line of the passage of the vein from the propylite into the syenite, would of course require a specially authorized examination of the mines; since a majority of points in which the east wall has been struck are hidden from view, either by the closure of drifts no longer essential to the working of the mines, or by timbering in the shafts, etc.

Many important deductions might be based upon a change in the conditions of the Comstock lode, which must be fraught with exceedingly important consequences to the greatest mining interest of the Pacific coast; but I prefer to confine myself to submitting the fact of this remarkable, and at this time most unexpected, alteration in the character of the vein.

[redacted]

number of new forms of ancient vegetation. At the bottom of the layer is found less than an inch of a very peculiar substance of vegetable origin of brown color, soft like rotten wood, without lamination and filled with fragments of a minute form of plant resembling an *Asterophyllites.* In it are fish scales indicating, according to Dr. Newberry, a new genus and species, and also a small *Lingula*, perhaps too indistinct for specific determination. Above the half-solidified brown band we find an inch of highly bituminous laminated cannel shale, presenting a satin surface in its fracture. This shale contains a few plants, the most numerous form being leaves of *Lepidodendron.* This shale passes upward into an ordinary bituminous shale, in the lower two inches of which nearly all the new plants are found.

We have here the evidence of a marsh in which there was acccumulated upon a micaceous sandy bottom the minute moss-like calamitoid plants. These were buried by a highly bituminous sediment into which fell innumerable leaves of *Lepidodendra*, long straight leaves, often a foot in length. Then came in a luxuriant vegetation, chiefly ferns, which are buried in the higher shale.

So far as I know, this marsh must have been of very limited extent, for I have found no trace of it in the same geological horizon elsewhere in the neighborhood. The shale, on its outcrop, is so deeply buried by soil that so far only a few square yards have been uncovered and examined.

In this little marsh grew plants of well-marked Devonian types, and others of a type generally found in formations more recent than the Coal-measures. Besides these, there are many Coal-measure forms, but with scarcely an exception, they are of new species.

Of the Devonian types, one is a new species of *Archæopteris* Dawson, (*Palæopteris* Schimper.) The *A. Jacksoni* Dawson, from the Devonian of New Brunswick and Maine may be regarded as the typical form of this genus. The new Ohio species I have called *A. stricta.* It is a fern of great beauty, smaller and more delicate than *A. Jacksoni.* The pinnæ are alternate, somewhat closely set, growing out of the rachis at an angle of 70° to 80°, rarely as small as 45°. The pinnules are alternate, oblanceolate, obtuse, decurring on the narrow rachis, disconnected to the base, with a strong nerve, dividing near the base into three to five branches, which themselves fork once or twice before reaching the margin. Prof. Fontaine reports the finding of *A. Jacksoni* (or possibly a closely-allied species), in his conglomerate coal series on New River, W. Va., over a coal seam perhaps 500 feet above the base of the Coal-measures. This is more than 1500 feet lower in the series of the Alleghany

Coal-measures than my Ohio form. He also finds the same *A. Jacksoni* in Vespertine slate in Greenbrier Co., W. Va.

Another Devonian genus found in the little marsh in Perry county is the *Megalopteris* Dawson. The only species of this genus known was first found in New Brunswick by Prof. Hartt and described by him as *Neuropteris Dawsoni*. Prof. Fontaine has recently found the same in the lower Coal-measures on New River, where he found the *A. Jacksoni*. Of this genus I have found four new species, which I have called *Megalopteris Harttii*, *M. ovata*, *M. lata* and *M. minima*. The first three of these are closely allied to *M. Dawsoni* Hartt. The last, *M. minima*, has much the appearance of an *Alethopteris*, but it is undoubtedly a true *Megalopteris*. Some of the new species were ferns of large size and of great beauty. This genus has special interest and value because found in the Coal-measures of Ohio, only about 700 feet below the great Pittsburgh seam of coal. The West Virginia species found by Prof. Fontaine came from a horizon more than 1500 feet lower. But from this horizon, which is low in the original geosynclinal trough or depression in West Virginia (described by me in another paper read at Detroit and published in this Journal for Oct.), it is a long way down to the Devonian formation, which, in New Brunswick, yielded to the hammer of Prof. Hartt his *Megalopteris Dawsoni*. The new species from Ohio are directly separated from any Ohio Devonian rocks by, first, a few feet of Coal-measure strata, second, by the lower Carboniferous Maxville limestone, the equivalent and representative of the Chester limestone of Illinois, there 600 to 800 feet thick, and third, by the Waverly sandstone, over 600 feet thick. These facts are of no little interest as showing the distribution in the great time-series of this genus of ferns. If, however, we should apply the republican rule of majorities to science, the finding of several species in the Coal-measures and but one in the Devonian would determine this to be a true Coal-measure form. Then the Devonian species becomes the prophetic one.

Growing in our little marsh with the *Archæopteris* and the *Megalopteris* is a new and beautiful fern of a new genus of a more recent type, the *Tæniopteridæ*. No form of this order has hitherto been found so low in the Coal measures. *Tæniopteris multinervis* Weiss, belongs to the upper Coal measures and Permian of Europe, but most ferns of this order are of Mesozoic age. The only American representatives of this group, so far as I know, are *T. magnifolia* Rogers, from the Triassic coal field near Richmond, Va., used with other plants by Prof. W. B. Rogers to determine the geological age of that field, and *T. vittata* Brongt., reported by Pres. Hitchcock, from the Red Sandstone of the Connecticut valley. The new Ohio genus I

ıave called *Orthogoniopteris*, from its rectangular nervation. Γhe following is a description of the genus:

Frond simply pinnate. Pinnæ alternate, lanceolate or oblong, inear, rounded or tapering to an acute point, entire or undulate, en-arged and decurrent on lower side, rounded on the upper to the nedian nerve, and joining it a little above the point of its attachment o the rachis. Median nerve prominent, thick and ascending to the ıpex. Nervules forking once very near the median nerve, extending ıt right angles to it, and curving upward slightly at the margin, ›ery fine, numerous and uniform.

Two species have been found, *O. clara* and *O. Gilberti.* This ;enus is allied to *Tæniopteris* Brongt., to *Angiopteridium* Sch., ınd to *Neriopteris* Newb. The nervation is similar to *Tæniop-eris*, but *Tæniopteris* has a simple frond, while this is pinnate. :n *Angiopteridium* the frond is pinnate and the pinnæ are cor-late or rounded, with a marginal fructification. In Dr. New-›erry's new genus, *Neriopteris*, the pinnæ are similarly cordate vith acute-angled nervation and with a supposed marginal fruc-ification. In this new genus the pinnæ are decurrent below, ınd free and rounded above, with a perfectly rectangular nerva-ion. In the decurrent base of the leaflets it is allied to the arger forms of *Alethopteris*, but it doubtless belongs to the or-ler of *Tæniopterideæ.*

Besides those already referred to, the bed affords a new ıpecies of *Alethopteris* greatly resembling *A. tæniopteroides* 3unbury, from the coal field of Cape Breton, but specifically lifferent. Another fragment of a supposed *Alethopteris* also ›ossesses a nervation much like the *Tæniopterideæ.* If a true *Alethopteris*, it is of larger leaf than any other species of this ;enus except *A. ingens* Dawson, from which it differs some-vhat in nervation. There is another *Alethopteris*, which I have :alled *A. Holdeni*, of great size and beauty, belonging to the ection of the genus which may be represented by *A. Serlii*, ınd is doubtless allied to Dr. Newberry's new species, *A. mac-'ophylla.* The essential characters which distinguish it are: irst, the great length of the frond, which measures at least fifty :entimeters; second, its lanceolate, or rather oblanceolate orm, the leaflets decreasing in length toward the base; third, he linear taper-pointed form of the leaflets, comparatively long ,nd narrow; and fourth, the always simple division of the rond. It is possible that we have in these various species of *Alethopteris*, and in closely allied forms, a group which should ›e detached and formed into a new genus This group passes, n resemblance, into the type of the *Tæniopterideæ* on the ›ne hand and through the *Megalopteris* (the *M. minima* having nuch the look of an *Alethopteris*) unto the distinct *Neuropteris* ype on the other. These resemblances are of great interest

and seem to bring the Devonian and Mesozoic flora into greater apparent harmony.

Besides the forms already mentioned the bed affords two new species of *Asterophyllites*, a new and beautiful *Hymenophyllites*, a new and pretty *Eremopteris*, two species of *Lepidodendron*—one allied to *L. tetragonum* Steenb., found by Dr. Dawson in the lower Carboniferous of Canada—two species of *Cordaites*, one probably *C. Robbii* Dawson, a Devonian form from New Brunswick, a new and large *Cardiocarpon*, a large fine cone of somewhat doubtful affinities, a curious jointed root and several other forms not yet determined. The most important of these plants are figured and will appear in the next volume of the Ohio Geological Reports.*

ART. LVIII.—*Letter to the Editors*, from Dr. B. A. GOULD, Director of the Córdoba Observatory, dated Córdoba, Sept. 8, 1875.

MESSRS. DANA & SILLIMAN:—When I took leave of you last November I did not intend that so long an interval should elapse without the fulfillment of my promise to send you tidings of the progress of my work. But what with the accumulation of material during my absence, and the relentless pressure of the current observations, I have been unable to do more than keep pace with the stream until now.

But now I have the gratification of informing you that the zone-observations are completed. There are 754 zones, containing somewhat more than 105,000 observations; the first zone having been observed 1872, Sept. 9, and the last 1875, Aug. 9, but as there was an interruption of about a year during this interval, not quite two years of work is comprised in the series. The measurement of the chronograph sheets and the transcription of the time-records is now completed; and the copy of the observations upon sheets ready for the printer is so far advanced that it will probably be completed before this letter can reach you. The second copy, upon computation-blanks, is likewise well under way.

Thus the entire region from 23° to 80° of South declination has been well scrutinized. The ten degrees around the pole have been so thoroughly examined by Gillis in Santiago and Stone at the Cape of Good Hope, that no zone observations seem needful there; and my northern limit overlaps Argelander's southern zones by eight degrees, in compliance with the special request of that deeply lamented astronomer.

The width of the zones has varied with their declination, and with the abundance of their stars; the maximum width being 2° at the northern limit, and 4° for the zones immediately north of

* Professor Andrews has sent us copies of his plates, and we can testify to their beauty and interest.—EDS.

75°, between which declination and 80° only one series was taken. These widths were always halved within the limits of the Milky Way, and still farther subdivided into quarters, and even eighths, where the richness of the region required; so that some zones have only comprised 20′ or 25′ of declination exclusive of their marginal overlap. The maximum number of stars contained in a single zone is 293, the average is about 140. It is needless to say that there are many repetitions, arising not only from the overlap, (usually 10′ at each margin), and five or six minutes of time at the beginning and end), but also from the re-observation of such zones as had proved unsatisfactory, whether from unfavorableness of weather, insufficient determining stars, or inadequate performance of circle, chronograph or clock.

It has been my unfailing rule to make the determinations as nearly absolute as circumstances would allow; and with this view, each zone has been preceded and followed by a series of observations for instrumental corrections,—consisting of transits of two standard time-stars, as well as of one circumpolar star above and one below the pole, together with measurements of nadir, collimation and level. But although these precautions have been taken, I do not purpose dispensing with the advantage to be derived from direct comparison with independent and sharply determined star-positions, and the catalogue of these is advancing very satisfactorily. My original plan implied the determination of some half dozen stars in each zone, selecting so far as it might be convenient, such as occur in the Uranometry. These would form a catalogue of about 3,000 stars, each of which was to be observed four or five times with all possible care. But when the zone-work was interrupted by my departure for home in 1874, I extended the list considerably, and thanks to the faithful and efficient labors of my assistants, this work was vigorously prosecuted during the year; so that there now remain comparatively few stars of the Uranometry, whose positions have not been independently determined in Córdoba. I purpose to employ the Meridian Circle for extending and improving this catalogue, while the reduction of the zone-observations, and the publication of the Uranometry are going forward, and have now extended the working list yet more, so that this catalogue will contain more than ten thousand stars, if all goes well, each star being observed on the average about four times. Up to the present time the total amount of different stars observed for this catalogue exceeds 7,000, although not all of them have as yet the requisite number of observations.

Besides the data thus collected I have a considerable amount of material resulting from the repeated observation of clusters. These observations, when properly reduced, will essentially aid the study of the photographic plates.

Now I must apply myself to the more laborious and difficult part of the work—the computation and preparation of the crude material obtained. This would be more difficult everywhere as requiring a more unremitting diligence, and careful organization,

but is doubly so in this country, where to the task of discovering persons fit to serve as computers, is added the labor of training them; and the dull routine of numerical computation naturally fails to enlist that popular appreciation and interest, which the process of instrumental exploration readily awakens, and in which the sinews of science must find their point of attachment. Still, I have every reason for confiding in the support of the Argentine people and government, which have never yet failed to respond favorably to any of my appeals. At the present moment the country is suffering from the severest commercial crisis which it has ever experienced; its treasury is depleted by last year's civil war, the agricultural industries of the whole land have been blighted by the ravages of locusts, and an almost unexampled drought; yet although almost all other appropriations have been cut down, those for scientific purposes have been maintained intact, and all which I thought it right to ask for the Observatory has been voted by the Congress.

Now, first of all, I hope to prepare the manuscript of the Uranometry, for which the charts are already begun; and while this is going forward I hope to prosecute various other subsidiary work. The reduction of the catalogue-observations is so well forward that within a couple of months after I shall have completed the recomputation of the circumpolar list (already far advanced), I think that the current observations for the catalogue may be kept reduced up to date. And very soon after the manuscript of the Uranometry is completed I think that at least one volume of instrumental observations can be sent to the press.

You will be glad to learn that after all the labor, vexation and expense, which my first photographic efforts had entailed, far better success is attending the second endeavor. The new lens seems to be quite equal to the original one, and on favorable nights we obtain images of stars which cannot be brighter than the $8\frac{1}{2}$ magnitude. Although the clock-work of the Equatorial is not equal to the demands upon it, the mechanical ingenuity and perseverance of the assistants has already done much, and will, I am confident, do yet more toward remedying the defects. And the lathe and tools for working in metals, which I brought out with me last December, have rendered most important service. Mr. Mansfield is now constructing a new governor, which will, we hope, secure a greater uniformity of movement to the telescope. Mr Heard, who is now engaged on the photographic work, is far more successful than his predecessor in the manipulation both of the telescope and the chemicals, and has already, in spite of many difficulties, obtained about seventy good plates, comprising twenty-four different clusters and many double stars. On one plate there are nearly or quite a hundred stars, in the cluster Δ.323. We have also been experimenting upon *Mars*, and the photographs show the detail of the surface quite clearly, but they are not as well defined as could be wished. I have now sent home orders for new enlarging lenses, for which, and for other photographic conveniences,

the Minister of Public Instruction has placed a small sum of money at my disposal from the contingent fund of his department. When I next write I think it will be possible to give you some encouraging accounts, and description of results in detail. As yet I have had no time to undertake any measurements of the plates, but if my plans do not prove amiss, this will soon be possible. I possess an exquisite micrometer for the purpose, the gift as well as the construction of our friend, Mr. Rutherfurd. I have been endeavoring to procure photographic impressions of *Eurydice*, and its comparison stars, for Dr. Galle's new investigations, but the stars are too faint.

The geographical determinations of various points of South America are going forward as opportunity permits. Since my return I have obtained satisfactory exchanges of signals with Santiago de Chile on two nights, and am waiting an additional exchange before deducing the final results. Messrs. Thome & Bigelow are now resting themselves from long continued labor at the Observatory by a journey of geographical exploration up the river Paraná. They carry with them a prismatic reflecting circle, which I obtained for such purposes from Pistor and Martius, and in the use of which they have already attained such proficiency that their respective time-determinations frequently agree to the tenth of a second. The sidereal clock of the Observatory, being connected with the telegraph line, is made to graduate a time-scale on the registers of both stations, while the observers telegraph the beats of a mean-time chronometer, for which they determine the error immediately before and after these signals. The position of the city of Paraná was thus determined three days ago; to-day we have accomplished the same for La Paz, which is about 100 miles farther up the river. The telegraphic communication only extends as far as Corrientes in $27\frac{1}{2}°$, but with the aid of their chronometer I trust they will be able to extend the longitude determinations as far as Ascencion, the capital of Paraguay, latitude 25° 16′. I have also made arrangements for an early determination of the positions of Tucuman, situated 260 miles north of Córdoba, and of San Juan at the base of the Andes, some 200 miles to the westward. You will remember that distances form no criterion of ease of access. About eight days are usually required for the journey to Tucuman, notwithstanding that the railroad now building is already nominally completed for half the distance, and the same is true in regard to San Juan.

In Dr. Petermann's new map of the Argentine Republic, just published, the results of my previous observations are incorporated, having been furnished him by Mr. Moneta, late Chief of the National Engineers, in connection with whom my determinations of Rosario and Buenos Aires were made, as I once wrote you. Before long I hope to be able to include in this series of determinations all the capitals of provinces, and the chief points of commercial or geographical importance, to which the telegraph extends.

The Meteorological office is quietly extending its influence and activity throughout the country. It is not easy to secure the gratuitous coöperation of competent and conscientious observers, nor to secure their reception of instruments in good condition; yet the success has thus far been all that I could have presumed to hope; and I am already rapidly accumulating data, which will disclose the heretofore unknown climatic and atmospheric relations of this vast country. Already some dozen or more stations are regularly transmitting their tri-daily observations, and arrangements are already in progress which give ground for confident expectation that this number will soon be doubled. Especially I have reason to believe that systematic observations will speedily be organized along the river Uruguay, in Patagonia, Tierra del Fuego, and the Falkland Islands. The most extensive railroad company in the province of Buenos Aires, and the provincial telegraph have promised their coöperation by establishing observations at their chief stations, and the Right Reverend Dr. Stirling, the English missionary Bishop of the Falkland Islands, has cordially interested himself in our undertaking, and will avail himself of the opportunities afforded by his official journeys to all the Anglican missions in this portion of the world to enlist the assistance of his clergy.

Before bringing this letter to a close I must add one more item of interest, viz., that the two Houses of the Argentine Congress have by decided majorities adopted the metric dollar of one and a half grams of pure gold, or one and two-thirds grams of alloy, nine-tenths fine, as the national monetary unit, the legal value of foreign gold coins to be determined on this basis by assays, and annually published by the Minister of Finance. That this unit is not already law is due solely to disagreement between the two houses on other points contained in the same bill; but the delay is only temporary.

Now that Japan and the Argentine Republic have adopted a metric basis for their monetary unit,—the only basis on which we can hope for any approach to international unification,—perhaps we may look forward to some corresponding action on the part of our own government. The United States dollar requires only a change of less than one-third part of one cent, (less than the limits of mint tolerance), and it would seem as though by the united action of our men of science, this desirable change might be effected during the present demonetization of gold. Such an act would be a most notable addition to our series of centennary celebrations, as it would be a most efficient step toward what the French term "the solidarity of nations."

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *An Air Damper for Balances.*—In order to reduce the time f oscillation of a balance to a minimum when in use, ARZBERGER as proposed the use of a damping apparatus containing air. To he stirrup, immediately under the end of the beam, a circular late of brass, gilded, is hung by a wire. This plate is 67 mm. in liameter and ½ mm. thick. It swings, when the balance oscilates, in a short cylinder 68 mm. in diameter and thus has a clear nnular space of ½ mm. between it and the cylinder. This latter s fastened to the balance case by a strip of brass, to which it is ttached by a screw in the center. The bottom of this cylinder as a hole on one side of this screw; so that by rotating the cylnder, the hole may be closed more or less completely by the rass strip. When the balance swings, the plate moves up and lown in the cylinder, the oscillation being checked by the resistnce of the air in the box, which may be adjusted at pleasure. The working of the attachment is said to be very satisfactory, ince the damping is a dynamic and not a static resistance. The lelicacy is not at all interfered with.—*Liebig's Annalen*, clxxviii, 82, Oct., 1875. G. F. B.

2. *On a Convenient method of Preparing Sulphuryl Chloride.* —BEHREND, in order to investigate the relations of the carbanides and sulphamides, found it necessary to devise some better nethod for preparing sulphuryl chloride. For this purpose he repared sulphuryl chlorhydrin by the action of hydrogen chloide upon sulphuric oxide, and distilled this continuously with a eturn cooler; but with no satisfactory result. It was then laced in sealed tubes and heated for 12 to 14 hours in a paraffin ath to 170°–180°. A brilliant mobile liquid, boiling at 70°, and vith an exceedingly irritating odor, was obtained, which had a pecific gravity of 1·661 and was the body in question. Its proluction is thus represented:—

$$\begin{matrix} SO_2\left\{\begin{matrix}OH\\Cl\end{matrix}\right. \\ SO_2\left\{\begin{matrix}Cl\\OH\end{matrix}\right. \end{matrix} = SO_2Cl_2 + SO_2\left\{\begin{matrix}OH\\OH.\end{matrix}\right.$$

—*Ber. Berl. Chem. Ges.*, viii, 1004, Sept., 1875. G. F. B.

3. *Action of dilute Mineral Acids on Bleaching Powder.*—KOPFER, under Schorlemmer's direction, has studied the action of lilute mineral acids on bleaching powder, with a view to ascerain whether hypochlorous acid is actually evolved as asserted y Gay Lussac and recently denied by Göpner, and if so, in what mount. The bleaching powder was prepared from pure slaked ime and chlorine, and contained 21·46 per cent calcium hypochlorite, 17·69 calcium chloride, 47·52 calcium hydrate, and 13·33 alcium oxide. A solution of 20 grams of this was made and

filtered. Two hundred cubic centimeters of the filtrate were taken and diluted to a liter, and the hypochlorite was determined by Bunsen's method in a portion of the solution. Other portions were then distilled with nitric, with hydrochloric and with sulphuric acids. The best result was obtained with the first of these acids, the chlorine monoxide (hypochlorous oxide) in the filtrate varying from 80·63 to 91·32 per cent of that originally present in the bleaching-powder solution. Hence the author concludes that when bleaching powder is distilled with dilute mineral acids an aqueous solution of almost pure hypochlorous oxide is obtained in amount rising even to 92 per cent of that in the powder. Hence he infers that bleaching powder contains either calcium hypochlorite with calcium chloride, or a compound of the constitution $Ca\left\{\begin{matrix}OCl\\Cl\end{matrix}\right.$, as proposed by Odling. The liberation of hypochlorous oxide from bleaching powder by chlorine, is strongly confirmatory of the latter view. Chlorine is not set free by the action of hydrochloric acid upon bleaching powder.—*Jour. Chem. Soc.*, II, xiii, 713, August, 1875. G. F. B.

4. *Method for the Quantitative Separation of Ferric Oxide, Alumina, and Phosphoric Acid.*—Having occasion to analyze a minute quantity of a mineral containing ferric oxide, alumina, and phosphoric acid, FLIGHT took the opportunity to examine the various methods in use for the separation of these substances, the results of which are given in his paper. As a result, he was led finally to adopt the following, which gave all desirable accuracy: The solution of the above named substances, which must not contain much free acid, is boiled for two or three hours with an excess of sodium hyposulphite (thiosulphate) and filtered. All the iron with some of the phosphoric acid is in the filtrate; all the alumina with some of the acid, is on the filter. The iron in the filtrate is thrown down by ammonium sulphide and determined as usual. The alumina precipitate is dissolved, and to the solution an excess of sodium hydrate is added, and then barium chloride so long as a precipitate is produced. After standing a few hours, the solution is to be filtered. The phosphoric acid remains on the filter as barium phosphate; the alumina is contained in the filtrate, from which it may be precipitated in the ordinary way and weighed. A little caustic soda added to the wash water prevents the solution of the barium phosphate. The barium phosphate is dissolved off the filter, the barium removed with sulphuric acid, the filtrate mixed with that from the iron sulphide above, and the phosphoric acid determined with magnesia mixture as usual. The author also points out that the corrosive action even of dilute solution of sodium phosphate upon the glass of reagent bottles is considerable and may be a source of error in analysis. This salt cannot be obtained pure by recrystallization in dishes of Berlin porcelain from this cause.—*Jour. Chem. Soc.*, II, xiii, 592, July, 1875. G. F. B.

5. *On the Gases enclosed in Coals.*—THOMAS has made an elaborate investigation of the gases occluded in coal as well as of

those which are evolved from fissures in the mines. The experiments were made upon the bituminous, or "house coals;" the semi-bituminous or steam coals; and the anthracite coals; all from the South Wales basin. In the first series, slices of coal were sawn from the middle of large cubes and a strip cut from the middle of each of these ⅝ of an inch square and 6 or 8 inches long. This was placed in a hard glass tube and connected with a Sprengel pump. Very little gas—only 2 or 3 cc. per 100 grams of coal—was liberated on exhaustion. The tube was then immersed in boiling water and kept there so long as gas was evolved. Additional quantities of gas were obtained at 200° and even at 300°. Upon analysis, the gases were found to consist of marsh gas, carbon dioxide, nitrogen and oxygen. The bituminous coals yield the least gas, though it contains a large percentage of carbon dioxide. Steam coals come next, their gas containing as much as 87 per cent of marsh gas. Anthracite yields most gas, one specimen giving 600 cc. of gas from 100 grams of coal, at 100°, 1000 cc. at 200°, and 1875 cc. in all at 300°. In composition these gases closely resembled those from steam coals. The gases collected from blowers in the mine as well as from the coal itself by boring, consisted almost entirely of marsh gas, rising in some cases to 97·65 per cent.—*Jour. Chem. Soc.*, II, xiii, Sept., 1875. G. F. B.

6. *On Chrysophanic Acid.*—LIEBERMANN and FISCHER have continued the researches made upon emodin by the first-named chemist, and have extended their investigations to chrysophanic acid. When distilled with zinc dust, it yields methyl-anthracene, as was proved by a minute examination of the properties and reactions of this hydrocarbon. Acetyl-chrysophanic acid was also preprepared and analyzed. It contains two acetyl groups. From these data it is clear that chrysophanic acid is dioxymethylanthraquinone and that it stands to emodin in the same relation that alizarin stands to purpurin. The authors notice the curious fact that while the madder-root contains anthraquinone-coloring matters which stand to each other in a simple oxidation series, the root of rhubarb contains a similar series, homologous with the derivatives of anthraquinone. Experiments were also made on the amides of chrysophanic acid.—*Ber. Berl. Chem. Ges.*, viii, 1102, Sept., 1675. G. F. B.

7. *On the Quantitative Determination of Vanillin in Vanilla.*—The introduction into commerce of the synthetically prepared vanillin renders some method desirable for its exact estimation. TIEMANN and HAARMANN have proposed a method founded on its aldehydic nature and its consequent union with acid sulphites. Thirty to 50 grams of the finely divided vanilla is repeatedly extracted with ether, the extracts united, the ether distilled nearly off, and the residue treated with an equal volume of a mixture of equal parts of hydro-sodium sulphite solution and water. On standing, two layers of liquid appear, which are separated by means of a separating funnel. The lower, which is the sulphite vanillin solution, is placed in a flask furnished with funnel and de-

livery tubes, through the former of which dilute sulphuric acid is poured, the evolved sulphurous oxide being conducted into a bottle containing soda. After the reaction is over, the liquid is extracted with ether, the ether distilled to a small bulk, the residue placed in a watch glass and allowed to evaporate spontaneously. Pure vanillin, fusing at 81°, crystallizes out; it is dried over sulphuric acid and weighed. After proving the exactness of the method, the authors used it in analyzing the vanillas of commerce. They found Mexican vanilla to yield 1·69 per cent, Bourbon vanilla 2·46 per cent, Java vanilla 2·75 per cent, and a second sample of Bourbon vanilla 1·91 per cent of vanillin. The prices of the various sorts of vanilla are even more discrepant.—*Ber. Berl. Chem. Ges.*, viii, 1115, Sept., 1875. G. F. B.

8. *On the Localization of Arsenic in the Tissues.*—SCOLOSUBOFF has investigated in Gautier's laboratory the distribution of the metalloid arsenic in the tissues and has found, contrary to the general belief, that it is specially condensed in the nervous tissues. The experiments were made with dogs, with rabbits, and with frogs. Dogs bear large doses of arsenic readily, being able to take without difficulty 15 to 18 times the quantity which weight for weight would be fatal to man. The arsenic was administered as sodium arsenite in the food. It was separated from the tissues by treating these with nitric mixed with a little sulphuric acid, evaporating nearly to dryness, adding more sulphuric acid, heating again till fumes appeared, then more nitric acid and heating to carbonization. On exhaustion with boiling water and filtering a liquid is obtained from which the arsenic may be precipitated by hydrogen sulphide. A bull dog took for 34 days gradually increasing quantities of arsenic from 5 milligrams to 150 milligrams per day. 100 grams of the muscle contained ·00025 arsenic, 100 grams liver ·00271, 100 grams brain ·00885, and 100 grams spinal cord ·00933 grams. Calling the quantity in 100 grams of muscle 1, that in the same weight of liver is 10·8, brain 36·5 and spinal cord 37·3. The results where the poisoning was acute were quite as marked. A dog of 11 kilograms was killed by the

The pile was placed about 30 cms. from the axis of the prism, d the breadth of the admission slit was half a millimeter; its gular magnitude as seen from the prism was 5′·7, conseqently ch cold band made its effect sensible through an angle equal its own angular width increased by 5′·7. The illumination slit so had a width of half a millimeter.

According to the measurements of M. Lamanski four cold lines the spectrum of the sun are distant from the extreme red by e angles 19′·1, 30′, 44′, and 51′. These positions are evidently the me as those of the lines given above by the absorption of a ntimeter of water. This coincidence seems to prove that the ld bands in the dark portion of the solar spectrum are in a great asure due to the water of the atmosphere.

Another series of experiments were made to compare the action erted on dark spectra by different solutions, formed by disolving solid capable of forming cold lines, in liquids nearly inactive in is respect. The active substance employed was iodine, which s dissolved in chloride of carbon, chloroform and sulphide of rbon. These three liquids dissolve iodine in large quanti-s, and all three solutions have the same appearance. A yer of liquid, one centimeter in thickness, was used and the sm and lenses were of flint glass. Three lines were observed ving the positions given below:

Chloride.	Chloroform.	Sulphide.
1° 28′	1° 30′	....
1° 34′	....	1° 35′
1° 55′	1° 57′	1° 56′

ese numbers show that the action of the iodine is the same in e three cases. In all the experiments observations were made that part of the spectrum where the iodine solution produced a e, so that the solvent and the whole refracting system had no tion in the production of the phenomenon.—*Comptes Rendus*, xi, 432; *Phil. Mag.*, l, 331. E. C. P.

10. *Luminosity of Flames.*—M. F. Wibel has examined the uses of luminosity and non-luminosity of flames. Knapp found at the flame of a Bunsen's burner became non-luminous if nitro-n, hydrochloric acid, or carbon dioxide be passed into the air les instead of air. Blockmann found that carbon monoxide and drogen have the same action, and the same effect is produced, Landon has lately shown, by steam. When, however, any such xture is very strongly heated before it undergoes combustion, again becomes luminous. This is best shown by fixing a plati-m tube into the upper end of the burner and heating it with o horizontal gas-jets. An iron tube may also be used instead of e platinum tube, but, on account of the higher specific heat of n, it must be more strongly heated. A copper burner cannot used, because it colors the flame green. The luminous flame pears as a cone between the inner dark cone and the outer blu-cone. This is not caused, as might be supposed, by the gases

of combustion of the two burners surrounding the colorless flame and thus keeping the oxygen away, inasmuch as the luminosity is equally well produced when the access of these gases is prevented by a large sheet of iron having a hole in it, through which the tube of the burner passes air-tight.

From these observations it may be concluded that the non-luminosity of a gas-flame is not caused by a dilution of the gas, this dilution being in fact increased by heating the mixture. The only cause is a cooling of the interior of the flame. This is further proved by the fact that it is most difficult to get a non-luminous flame from a mixture of coal-gas and oxygen, showing that neither rapid oxidation nor dilution produces the non-luminosity.—*Deut. Chem. Ges. Ber.*, viii, 226; *Jour. Chem. Soc.*, xiii, 603.

E. C. P.

11. *Rotatory Polarization of Quartz.*—MM. J. L. SORET and E. SARAZIN have repeated the experiments of Broch and Stefan extending them to the more refrangible portions of the spectrum. The light of the sun concentrated by a lens 1·15 m. focus and 72 mm. in diameter, was passed through two Nicol prisms with a plate of left-handed quartz 30·085 mms. thick between them. It was then observed with the fluorescent eye-piece of M. Soret. For the rays *A* and *a*, a piece of cobalt glass was interposed to cut off the adjacent bright light.

	λ	φ	Δ
A	760·0	12°·68	+0·10
a	718·5	14·33	·00
B	686·7	15·75	·00
C	656·2	17·35	·00
D	588·9	21·79	—·05
E	526·9	27·61	—·06
F	486·07	32·65	—·07
G	430·72	42·63	+·06
h	410·1	47·52	—·05
H	396·8	51·22	·00
L	381·9	55·88	—·08

[redacted]

observation. In the annexed table, column I. gives the name of the various lines, column II. their wave-lengths, column III. their observed angle of rotation, each being the mean of from six to forty-six observations; the last column gives the difference between column III. and the value computed by the formula given above.—*Comptes Rendus*, lxxxi, 610. E. C. P.

12. *Researches on the Hexatomic Compounds of Cobalt;* by Wolcott Gibbs, M.D. 51 pp. 8vo. From the Proceedings of the American Academy of Arts and Sciences, vol. xi.—The earlier parts of Dr. Gibbs' researches on the cobaltamines have been published in this Journal, and will be found as follows: III, vol. vi, p. 116; also vol. viii, p. 189 and p. 284. For the conclusion of the memoir the chemical reader is referred to the article of which the title is given above; notwithstanding its great value, the length is so considerable as to make the republication in this Journal hardly possible.

13. *Professor Tyndall and Professor Henry on Sound.*—The following criticisms are here cited from a notice of the new edition of Prof. Tyndall's work on Sound (1875), in "The Nation" for October 28:

"The reader who turns to this seventh chapter will find that it opens with an 'introduction' professing to give 'a summary of existing knowledge' in the matter of fog-signalling. The writer states that while the *velocity* of sound has formed the subject of repeated and refined experiments by the ablest philosophers, 'the publication or Dr. Derham's celebrated papers in the Philosophical Transactions for 1708 *makes the latest systematic inquiry into the causes which affect the intensity of sound in the atmosphere.*' And, after making this statement, the Professor immediately adds as follows: 'Jointly with the Elder Brethren of the Trinity House, and as their scientific adviser, I have recently had the honor of conducting an inquiry designed to fill *the blank here indicated.*' In order still further to impress on the reader a sense of the magnitude of this 'blank,' Dr. Tyndall indulges in one or two preliminary references which, he says, 'will suffice to show the state of the question when this [his] investigation began.' The first of these references cites the opinion of Sir John Herschel to the effect that fogs and falling rain, and more especially snow, had been found by Derham 'to tend powerfully to obstruct the propagation of sound.' The second of his references is made to what he calls 'a very clear and able letter' addressed by Dr. Robinson of Armagh to the British Board of Trade in 1863. In this 'very clear and able letter' Dr. Robinson states that sound is the only known means for coping with fogs, but about it, the 'testimonies are conflicting, *and there is scarcely one fact relating to its use as a signal which can be considered as established.*' But Dr. Robinson is clear on one point—to wit, than 'fog is a powerful damper of sound.'

On the strength of these historical references, Dr. Tyndall ventures the remark that, prior to the investigation conducted by

him, the views enunciated under this head by Derham, Herschel, and Robinson 'were those universally entertained.' It was in order to fill 'the blank' indicated by the universal prevalence of such erroneous opinions that *his* inquiry, he says, was set on foot. And his inquiry, he tells us, was begun on the 19th of May, 1873.

Now, it is a matter not only of scientific knowledge, but of public notoriety in this country, that extensive researches on 'the cause which affect the intensity of sound in the atmosphere' had been made by the United States Light-House Board long before Prof. Tyndall began his investigations. That he should have chosen to ignore the fact in the body of his present volume becomes only the more surprising when, on turning to its preface, we find that he was, as he confesses, 'quite aware *in a general way* that labors, like those now for the first time made public, had been conducted in the United States,' and 'this knowledge,' he subjoins, 'was not without influence upon my conduct.' If his knowledge of the similar labors conducted under this head in the United States was not, as he acknowledges, without influence on his conduct in giving direction to his researches, it will naturally occur to ordinary minds that this knowledge should also have been 'not without influence' on his pen when he was professing to give a summary of the existing state of science on this subject. And when to this statement of the case, as acknowledged by himself, we add that he was made acquainted with the nature and purport of Prof. Henry's explorations on this question, not only 'in a general way,' but also in a very special way, it becomes still more inexplicable that in defining 'the blank' which he claims to have filled by his recent inquiry, he should have disregarded the labors and results of American science, and that too while profiting by the instruments and methods of that science in the very conduct of his investigations. The reader will understand the force of our remark that Prof. Tyndall was acquainted with the researches of Prof. Henry, not only 'in a general way,' but also in a special way, when we state that a paper by the latter—on the abnormal phenomena of sound in relation to fog signalling—was read by its author in the hearing of Prof. Tyndall at a meeting of the Washington Philosophical Society, called for the purpose of doing honor to the British savant while he was sojourning in the national capital. And the force of our remark that he has ignored the results of American science in magnifying 'the blank' which he describes, while profiting by the instruments and methods of that science in conducting his inquiry, will be understood when we say that the researches of Prof. Tyndall were prosecuted with the help of a steam-syren, gratuitously lent to him by the Light-House Board at Washington, constructed and patented by a citizen of New York, and introduced by Prof. Henry into the light-house system of the United States." * * *

"It is no part of our present purpose to institute a critical inquiry into the conflicting views of Prof. Henry and of Prof. Tyndall with regard to the hypotheses respectively espoused by

each for the explanation of the phenomena of sound in its passage through wide tracts of air. Prof. Henry believes that the direction and the rate of wind-currents are important elements in the problems presented by the phenomena in question. Prof. Tyndall admits that 'the well-known effect of the wind is exceedingly difficult to explain,' but he insists on making up the fagot of his scientific opinions on the subject at once and for ever without taking the 'viewless winds' into his account. He finds a sufficient explanation of all the abnormal phenomena in the assumption of ideal clouds of vapor mingling with the atmosphere so as to disturb its homogeneity, and thereby quench the body of sound. There is nothing in the working hypothesis of Prof. Henry which excludes any truth there may be in the working hypothesis of Prof. Tyndall. But in the present provisional state of his inquiries on the subject, the former is disposed to question the sufficiency of the explanation adduced by the latter as an efficient cause of all the phenomena in question. With the modesty and reserve of the true physical philosopher, in the present unfinished state of scientific inquiry, Prof. Henry waits for the wider knowledge which shall furnish the basis of an assured induction meeting all the requirements of the problem."

14. *A new Treatise on Elements of Mechanics, establishing strict precision in the meaning of Dynamical terms, accompanied with an Appendix on Duodenal Arithmetic and Metrology*; by JOHN W. NYSTROM, C.E. 352 pp. 8vo. Philadelphia, 1875. (Porter & Coates.)—This volume contains a great number of problems in practical mechanics, with concise and excellent solutions, and some useful tables. The author makes some innovations in the technical language of the science, which are not likely to be considered as in all respects improvements, and some of the topics treated in the volume are rather irrelevant to the subject. A. W.

II. GEOLOGY AND NATURAL HISTORY.

1. *Primordial fossils in pebbles of the Newport (Rhode Island) Conglomerate.*—Prof. WM. B. ROGERS, in the Proceedings of the Boston Society of Natural History for 1875, p. 97, discusses the origin of the flattened form of the siliceous pebbles or stones of the Newport conglomerate, and attributes it to sea-shore attrition. He also announces the discovery of many stones from the beach, that were derived from the conglomerate, which are "crowded with well-preserved impressions" of the Potsdam *Lingula*, similar to those found by him, several years since, in masses of the same conglomerate at Fall River, 17 miles to the east of north of Newport. Some impressions of the same fossil, less distinct, he has observed in the rock in place at Newport.

2. *Bowlder near Batavia, Genesee County, New York.*—The bowlder "on the road from Caledonia to Batavia," figured by Hall on page 341 of his Report on New York Geology (1843), and stated to consist of Hydraulic limestone from the upper part of the

"Onondaga Salt group," has the following dimensions, according to a recent letter to one of the editors received, along with an excellent stereoscopic photograph, from Mr. J. G. Fargo of Batavia: height 12 feet; width of base 20 feet, of neck 8 feet, of top 14 feet. It is underlaid by about 40 feet of drift, beneath which is the Corniferous limestone.

3. *On a method of distinguishing the different Feldspars by means of their optical properties;* (Extract from a letter from M. DesCloizeaux, dated Villen-sur-mer, July, 3d, 1875.) * * * This method can be applied to all the feldspars, and gives a much easier means of distinguishing them than those described in my last memoir (this Journal, III, ix, 322). It is only necessary to obtain a section, sufficiently thin and transparent, parallel to the easiest cleavage [p] and smooth enough to be homogeneous in all its parts. Similar sections obtained from crystals or lamellar masses of albite, oligoclase, labradorite, and the majority of those of microcline, show hemitropic bands, more or less close together, arranged along the plane parallel to the second cleavage [g^1]; for orthoclase and microcline in *simple crystals*, two sections placed in opposite directions serve to produce the same effect. These sections are thus brought between the crossed Nicols of a polarization-microscope.

(1.) For *orthoclase* the maximum extinction takes place when the two sections are parallel to their plane of contact; the edge $p\,g^1$ being in the plane of polarization of the microscope.

(2.) For *microcline*, the whole structure consists of a multitude of very fine parallel bands; we have microline alone, either hemitropic or not hemitropic, or microcline and orthoclase; the extinction can take place at 30° 54′ between the adjoining bands of the same plate of the macle (microcline alone), at 30° 54′ between the two plates of the macle (microcline in bands), or at 19° 27′ between the adjoining bands (microcline and orthoclase.) In the last case the whole of two lamellæ of the macle show at the same time an extinction oblique to the plane of composition, belonging to the microcline, and one parallel to this plane for the orthoclase.

(3.) For *albite*, the extinction between two bands takes place at an angle of 6° 32′.

(4.) For *oligoclase*, the extinction is simultaneous in the two bands, and when the plane of composition coincides with the plane of polarization of the polariscope, it shows that the structure is homogeneous.

(5.) For *labradorite*, the extinction takes place at 10° 24′ between the alternate lines of the hemitropic lamellæ.

It follows from this that a plane normal to the plane of the axes cuts the base along a line making with the edge $p\,g^1$ the following angles:

0° in orthoclase and microcline
19° 27′ in microcline.
3° 16′ in albite.
7° 12′ in labradorite.

I shall determine the same angle for anorthite when I return to Paris. * * * . E. S. D.

4. *Contribuzoni Mineralogiche per servire alla Storia dell' Incendio Vesuviano del Mese di Aprile*, 1872, *memoria di* ARCANGELO SCACCHI. Parte seconda, 69 pp. quarto. Naples, 1874.—The first part of Scacchi's valuable memoir on the eruption of Vesuvius in the Spring of 1872 was published two years since. The second part includes descriptions, mostly crystallographic but also to some extent chemical, of the following species, produced by the eruption: hematite and magnetite, tenorite (melaconite), *atelite*, sylvite and halite, sal ammoniac and *cryptohalite*, *chlorocalcite*, cotunnite and *pseudocotunnite*, *erythrosiderite*, molisite, *chloromagnesite*, *chlorallumininite*, aphthitalite, anhydrite, *cupromagnesite*, *chlorothionite*, *microsommite*, pyroxene, byssolite, *hydrofluorite*, *proidonite*, chrysolite, apatite. The names of the new species are printed in italics; their principal characters are given below, with the exception of several already described in Appendix II, to Dana's Mineralogy, 1875.

Atelite; produced by the action of hydrochloric acid on the lamellar crystals of tenorite (melaconite), by which their color is changed from black to green. Its composition is expressed by the formula 2CuO, CuCl+3HO.

Cryptohalite; a fluosilicate of ammonia, associated with sal ammoniac, and having the composition $2NH^4Fl, SiFl^2$.

Pseudocotunnite; occurs with cotunnite in acicular yellow crystals, opaque and lusterless. In water they lose their color, dissolve in part, and the remainder separates as a white powder. Composition, probably expressed by the formula PbCl, KaCl.

Chlorallumininite; composition Al^2Cl^3, xHO, associated with molisite, and chloromagnesite; decomposes on exposure to the air.

Chlorothionite; found in crusts of an azure-blue color, an analysis of which agreed approximately with the formula Ka, Cu, Cl, So^4.

Hydrofluorite; hydrofluoric acid, HFl; proidonite, $SiFl^2$; both products of the eruption of 1872. E. S. D.

5. *Materialien zur Mineralogie Russlands;* von N. VON KOKSCHAROW. Vol. vi, pp. 209-407, with index, vol. vii, pp. 1-176, 8vo. St. Petersburg, 1874, 1875 The crystallographic researches of M. von Kokscharow are always remarkable for their thoroughness and great exactness. The volumes, or better parts of volumes, last published, include memoirs upon a large number of species, of which the following are some of the more important: native copper, vi, p. 209; aragonite, p. 261; dioptase, p. 285; scorodite, p. 307; gold, p. 321; sulphur, p. 368; perofskite, p. 388. Dolomite, vol. vii, 1; barite, p. 25; calcite, p. 59; crocoite, p. 97. E. S. D.

6. *Memoire sur la Famille des Pomacées;* par J. DECAISNE.—A detailed analysis of Decaisne's monograph of the genus *Pyrus* was given in this Journal (3rd ser., iv, 489, Dec., 1872). Some of the views taken in that work are fully expounded in the present paper, which is separately issued from the Archives du Museum,

x, pp. 113–192, tab. 8–15, imp. 4to. The results of a prolonged study of an important group, by a botanist of great experience and ability, is worthy of particular attention. As the veteran author states it :—

"My principal object is here to call the attention of botanists to certain characters which have been neglected in systematic works, by the aid of which the ancient genera [merged in *Pyrus* by most of the recent systematists] may be neatly circumscribed. Such is the constancy and the value of these characters that the details of organization peculiar to each generic group may be expressed by very general propositions, which is the very object of a good method. Indeed, when a special organization is common to a large number of different plants, it is evident that comparatively slight but constant modifications of this structure ought to be particularly attended to; and this proposition seems to be especially true of the *Pomaceæ*." M. Decaisne puts foremost his strongest point when he declares of the Quince, that "the nature of its bark and wood, its prefoliation, inflorescence, the æstivation of the corolla, the structure of the ovary and of the fruit differ essentially from that of the Pears, among which certain botanists still class it." Rather than combine the Quince and the Japan Quince with *Pyrus*, we are confident that botanists will generally accept his *Docynia*, along with *Chænomeles* Lindl. and *Cydonia*, as independent genera. The same may be said of *Mespilus ;* and it must be allowed that the character which Kunth had noticed and which Decaisne has turned to account, that of the deformation of one of the ovules which becomes a kind of stipitate hood for the other, being common to it and to *Cratægus*, indicates a relationship to the latter genus rather than to *Pyrus.* Much nicer and more questionable characters are assigned to the genera here re-established from *Pyrus* in the Candollean sense, to which we are in this generation accustomed. These are, *Aronia* Pers., our Chokeberry (in which eight species are set up from what we take to be a single polymorphous one); *Sorbus* Tourn., the Mountain Ash (the synonym *S. microcarpa* omitted from *S. Americana*, and *S. sambucifolia* is still taken to belong only to our western coast, whereas it extends across the continent); *Aria* Host., the Beam Trees, all of the Old World; *Torminaria* Roem., for *Pyrus torminalis ;* also *Cormus* Spach, for *Sorbus domestica* L., the Service-tree of Europe, with *Pyrus trilobata* DC., and an allied species; *Micromeles*, a new genus for four Himalayan species thus far little known; lastly *Malus* Tourn. Here it is to be observed that *M. diversifolia* is held to be distinct from *M. rivularis ;* and that a subgenus, *Chloromeles*, proposed for *M. angustifolia*, our narrow-leaved Crab-Apple, thus widely separated from *M. coronaria*, on account, as is stated of its reddish anthers and the structure of the disk. *Pyrus* Tourn., is thus brought down to the Pear; and this, as Decaisne had formerly announced, to a single collective species, of six geographical *proles* or forms. We continue to write *Pyrus* from old habit and custom, not doubting, however, that *Pirus* is the correct orthography.

Of *Amelanchier*, following Lindley, there are enumerated twelve species, six for the Old World and six for North America, and there are names for four more. Without being able to clear them up (and no wonder), Decaisne thinks that they may be distinguished into at least three groups, characterized by the distinct or united styles, and the glabrous or downy ovaries. We are continually impressed with the idea that there must be three or four American species, and the seeds may aid in their definition. But thus far the characters elude investigation. *Peraphyllum* Nutt., referred by Bentham and Hooker to *Amelanchier*, has not been studied by Decaisne. When he examines the excellent specimens in flower and in fruit, which Mr. Siler has supplied from Southern Utah, he will conclude that the genus must certainly be reinstated. The likeness is only in the peculiar structure of the fruit.

As respects the remaining genera, the difference between this monograph and the disposition in Bentham and Hooker's Genera Plantarum is mainly this: *Eriobotrya*, with its baccate fruit (what is termed endocarp reduced to a soft pellicle), large turgid seeds with thickened cotyledons, and undulate petals, is upheld as a good genus: *Heteromeles* is adopted from J. Roemer for the Californian *Photinia arbutifolia*, and a second (probably not good) species, *H. Fremontiana*, is added. The characters appear to be the 10 instead of 20 stamens, in pairs opposite the calyx-lobes, their filaments dilated at base and somewhat monadelphous. In the tabular conspectus the petals are said to have "préfloraison tordue," but in the generic character it is "æstivatione imbricativa vel convolutiva," the latter term with the French botanists meaning the same as imbricated only more enrolling. The diagram represents the whole five petals with one edge covered, i. e., "tordue" or contorted (or, as we say, convolute), and so we find them in all the flower-buds now examined. But before adopting the genus it may be well to examine the *Photiniæ* generally. *Photinia*, of which *P. serrulata* is the type, is characterized as having imbricative æstivation, and Decaisne's diagram represents it as regularly (i. e., quincuncially) so. But in *P. prunifolia* and in *P. Blumei* we find occasionally only one exterior petal, and the four others successively overlapping in the "contorted" way; and in one of Wallich's specimens of *P. integrifolia* the first flower-bud inspected showed the "contorted" æstivation complete. This is also the case in *P. dubia* (in one of Hooker's and Thompson's Khasyia specimens), and this Decaisne refers to *Eriobotrya*, which has imbricative æstivation. Next is *Pourthia*, a new genus of eleven Japanese and Indian species, the type being *Photinia arguta*, *villosa*, *lævis*, &c., and the character, among others, "æstivatione contorta." But we as commonly find one petal wholly exterior. So we think it evident that the æstivation of the corolla furnishes no characters for the division of the genus *Photinia*.

Finally, as to the proper stone-fruited genera, *Pyracantha* is adopted from J. Roemer, for *Cratægus Pyracantha* and an allied Indo-Chinese species, and placed near *Cotoneaster*; and a character

not before used is introduced, namely, the position of the cotyledons, which, in this genus are, as regards the rhaphe, accumbent.

There are eight plates, six of them filled with admirable dissections, neatly done upon stone by Riocreux from the author's sketches. A. G.

7. *Elementary Lessons in Botanical Geography;* by J. G. Baker, F.L.S.—These first appeared as articles in the Gardeners' Chronicle, where they attracted attention as interesting and very readable sketches of the leading facts respecting the geographical distribution of plants, and the elements of climate which control this distribution. It appears that they were written by Mr. Baker, of the Kew Herbarium, and Lecturer on Botany at the London Hospital. Now collected, they form a neat 18mo volume, of 110 pages, a sort of "science primer," published by Lovell Reeve & Co., London, 1875. A. G.

III. Astronomy.

1. *Observations on the late Transit of Venus at Beechworth, Victoria;* by Dr. Henry J. Anderson.—The following interesting description of the observation of the late Transit of Venus, at Beechworth, Victoria, by Dr. Henry J. Anderson of this College, is taken from a letter addressed to me which has just been received and which bears the date Srinagar, Cashmere, India, August 30th, 1875. The telescope used has a clear aperture of 77 millimeters and a focal length of 1·125 meters. It was made by Secretan of Paris.

"The telescope was subjected, for this purpose, to chosen tests by Mr. Lewis Rutherfurd, then in Paris, and always so ready to oblige. I used the lower magnifying power, 98 I believe. Various circumstances interfered with my obtaining an observation of the exact moment of the first external contact. I did not see the planet until at least twenty degrees of its limb was on the sun's disc. This occurred at $11^h\ 31^m\ 40^s$, Melbourne time, as sent by telegraph from Melbourne to Beechworth where I observed. Thirteen seconds had probably elapsed. At $11^h\ 35^m\ 30^s$ the interior tangents to the two obtuse cusps were at right angles to each other. At $11^h\ 45^m\ 29^s$ these tangents were to all appearance parallel. At $12^h\ 0^m\ 9^s$ the cusps (then singularly sharp and well-defined) were distant from each other about one-seventh of the diameter of the planet. The atmosphere at this time was all that could be desired. A remarkable calm and clearness of the sky prevailed. There was no cloud, or even fleeciness in the direction of the sun, which was then only fifteen degrees from the zenith. As the observation was made with a diagonal eye-piece, the great altitude of the sun was very favorable to steadiness and distinctness of view, both from the position of the observer and the condition of the atmosphere. The instrument was adjusted as to focus, etc., as nearly as possible in accordance with the recommendation of Messrs. André and Wolf, and whatever may have been the cause, nothing in any way resembling the "black drop" made its appearance, either as the first internal contact drew nigh

or at any other time. The cusps approached each other with a motion geometrically, and to me surprisingly, precise; without bluntness, flickering or vibration. Such portions of the planetary disc as were near or between the cusps, seemed visibly less dark than the main portions more remote; but this gradation of hue was limited in extent and apparently without influence on the formation of the luminous thread.

Just preceding the union of the cusps the approaching points seemed to lose for a second or two the regular precision of their motion toward each other; but the filament once formed did not appear to me to break again. This phase occurred at Beechworth [longitude 146° 43′ 0″ = 9^h 46^m 52^s E. of Greenwich, latitude 36° 21′ 40″ S.; height above sea level 1800 feet] at 11^h 0^m $24^s \cdot 6$ Melbourne mean time; subject to any error, against which all possible precautions were taken, either in the telegraph from Melbourne or in the chronometer carried from the telegraph office to the place of observation.

Not many minutes had elapsed after the first internal contact when a sudden change of weather ensued. A high wind sprang up and dense clouds, at intervals, quite obscured the sun. At two P. M. the planet ceased to be visible and no phase of the egress could be observed. I wish to express my warmest thanks to Mr. William J. Turner, not only for the use of his grounds, but for his skillful aid in securing for me a steady manipulation of the telescope and its appendages.

The longitude and perhaps the latitude of the place of observation, no doubt need some slight correction."

L. WALDO.

Columbia College Observatory, N. Y., Oct. 16th, 1875.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *The Anderson School;* letter to the Editors of the Evening Post from Prof. ALEXANDER AGASSIZ.—A letter signed "E," lately printed in the Evening Post, contains certain charges against the trustees of the Anderson School. Before answering them the position of the director and trustees toward Mr. Anderson may be briefly noticed.

It may or may not have been known to Mr. Anderson that only the urgent solicitation of Professor Agassiz overcame my reluctance to serve as one of the original trustees of the school at Penikese. My appointment as his successor was against my own wish, and of this Mr. Anderson was fully aware. It was always agreed between Professor Agassiz and myself—and the founding of a summer school in no wise changed this understanding—that as his scientific executor the care of the museum at Cambridge should be my special charge, and that toward its support alone whatever I could contribute personally or command from others would be applied.

I held the nomination as director of the Anderson School, left in writing by Professor Agassiz, in abeyance, until early in 1874 the opportunity occurred to confer with Mr. Anderson, when I ex-

plained to him my position with reference to the museum at Cambridge. He, therefore, knew that, should this nomination be accepted, the duties of the director of the school must remain subordinate to those of the director of the museum, and that the interests of the former would not be allowed to interfere with the prospects of the latter. With this reservation, and the condition that Mr. Anderson would contribute the sum of $10,000 towards the support of Penikese for the next three years, I agreed to serve. This sum was considered as probably sufficient to carry on the undertaking until the future of the museum was assured. Of this $10,000 Mr. Anderson subsequently forwarded $1,329.60 (the check mentioned by your correspondent to the trustees), notifying them at the same time that for "reasons satisfactory to his own mind" he declined to make any further pecuniary sacrifices for the school. Neither the director nor the trustees could assume the responsibility thus left to them.

With this explanation I may now take up the charges of your correspondent. He says it was "authoritatively stated" that $10,000 of the Anderson Fund remained unexpended, and would suffice for the sessions of 1874 and 1875. No such statement was made, and no such sum existed. With the sanction of Mr. Anderson, the bulk of the "nucleus of an endowment fund" had been devoted by Professor Agassiz not only to buildings and equipment, but also to the running expenses of 1873. It was found, before the opening of the session of 1874, that these expenditures amounted to $47,000. There remained from the Anderson Fund not the $10,000 which figures so largely in the letter of "E," but about $1,100 available to the trustees. With this and $1,500 realized from the yacht Sprite, sold with the consent of Mr. Galloupe, the school reopened. As far as the interests of education were concerned the second session was a decided success, thanks to the interest taken by the teachers; but the institution remained in debt, and Mr. Anderson, to whom an informal account was sent, contributed, as above stated, $1,329.60 to pay the "actual deficit." This left the trustees to provide for existing liabilities, or be reproached, as they now are, with "needlessly sacrificing" the property under their charge. No appeal was made to Mr. Anderson beyond what he had himself proposed to do for the school. It is not true that he was "permanently laid under contribution - under penalty." It is not true that the condition of the school was kept back from him, or that the trustees had not the courtesy to signify to Mr. Anderson their intention of closing it. He has at all times been kept fully informed, partly by letters and partly in conversation, of its condition and prospects, as far as they were known to the trustees themselves.

They made every effort to save the school, to put it on a safe foundation, to make it self-supporting. A guaranty fund of $3,000 was contributed by a member of Professor Agassiz's family, and a very slight permanent support from the public would have enabled them to continue an institution which they close with deep regret. Receiving no such support they decided to wind up the

affairs of the school, a contingency of which Mr. Anderson was duly notified early in 1875, after he had of his own accord dissolved the conditions upon which alone the present director consented to serve. This brings me to the suggestion, made in the form of an accusation, that the trustees of the Anderson School, and by implication the trustees of the museum, might have appropriated a small portion from the Teachers' and Pupils' Fund of the Agassiz Memorial and have applied it, in "better faith and better morals" to paying the debts of Penikese. Neither the trustees of the Anderson School nor the trustees of the museum have any control over the Teachers' Fund. It was raised with the understanding, plainly stated in the circulars issued at the time, that it would be devoted to carrying out the plans of Professor Agassiz for the museum at Cambridge. That this will be done with the full appreciation of the relations which existed between him and those who have borne such affectionate testimony to his memory, every teacher throughout the country may be sure. But the use suggested by your correspondent would have been a strange misappropriation of money contributed for a special purpose.

As to the charge which seems directed against the trustees of the museum, as well those of the Anderson School, that they have trodden on the memory of their former director, the fact that these boards include several of Professor Agassiz's warmest friends, two of his favorite pupils, his brother-in-law, his son-in-law and his son, is a sufficient refutation of this calumny.

Finally, no insults have ever been offered to Mr. Anderson by the trustees, unless their decision not to become indefinitely responsible for the expenses of the school, and to close an institution which no one but themselves seemed inclined to support, can be so construed.

Cambridge, October 12, 1875.

2. *Annual Report of the Board of Regents of the Smithsonian Institution for the year* 1874. 416 pp. 8vo. Washington.—In addition to the report of the progress of the Institution in its various branches, the present volume includes the usual Appendix of Scientific Memoirs. The Memoirs in this new volume are: Eulogies on Laplace, Quetelet and Auguste De La Rive; on tides and tidal action in harbors, by Prof. J. E. Hilgard; Observations upon the electricity of the atmosphere and the aurora borealis, made during the Swedish expedition of 1868 to the north pole, by Prof. Selim Lemström of Helsingfors; On a dominant language for science, by Alphonse de Candolle; On underground temperature, by C. A. Schott; On a series of earthquakes in North Carolina, commencing Feb. 10th, 1874, by Prof. Warren du Pré; on the transactions of the Society of Physics and Natural History of Geneva, from June, 1872, to June, 1873, by A. De La Rive; On warming and ventilation, by A. Morin.

Under the head of ETHNOLOGY, has been collected a series of valuable observations, comprising an account of ancient graves of California, by Paul Schumacher; also descriptions of various

antiquities from Illinois, Ohio, Kentucky, Lake Superior, Mississippi, Tennesse, New York, Indiana, Maryland, North Carolina, and Florida.

3. *Croll on Climate and Time.* — Professor Croll's work on Climate and Time, noticed on page 232 of this volume, has been republished by Messrs. Appleton & Co. of New York.

4. *A Course in Descriptive Geometry for the use of Colleges and Scientific Schools;* by WILLIAM WALTER, Ph.D. (Boston, L. Prang & Co.)—In this work the treatment is concise without serious omissions or inadequate explanations, and yet sufficiently full without verbosity. The fact that a text of fifty pages requires a table of contents of eleven pages, shows how little needless description is given. Doubtless much of the saving of space is due to the convenient and expressive notation adopted.

The introduction of a series of stereoscopic views of many of the problems is a novel feature, and will doubtless materially aid the student in the place of models. It must not be forgotten, however, that a large part of the value of Descriptive Geometry arises from its training the student to conceive of objects from their projections; hence the value of any such aid, except to initiate the student in his work may be questionable. The collection would have been improved by the addition of one or two more warped surfaces, especially the hyperbolic paraboloid and conoids, which always give trouble to the student. The typographical execution of the work is excellent and the drawings accurate and easily understood. E. C. P.

5. *American Naturalist.* — The American Naturalist will be published the coming year by Messrs H. O. Houghton & Co., Cambridge, Mass., and will appear in new typographical dress. The Journal has hitherto been well conducted, always able in its articles, and while popular in its aim, never popular at the expense of its science. It is announced that the Naturalist will be improved under its new publishers by fuller notices of current science, and in other ways.

6. *School of Geology in the University of Syracuse.*—Under Professor Winchell a school of Geology has been organized in connection with the Syracuse University. It includes a course of Elementary Study or Undergraduate Course, and two Graduate Courses, one Lithological and the other Paleontological, carried on together. There are also to be special studies in different departments of Zoology, as in that of Corals, Brachiopods, Trilobites, &c. The school is intended for special geological students, and also for those who desire a general acquaintance with the subject. The school will open on the 25th of next January. The prospectus announces that Prof. Winchell will be aided in the school by Prof. J. J. Brown in Chemistry, Prof. F. Smalley and Rev. S. R. Calthrop in Geology, Profs. B. G. Wilder and Smalley in Zoology, Profs James Hall, R. P. Whitfield and E. D. Cope in Paleontology. The position of the school in central New York is particularly favorable for the geological and paleontological student.

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ART. LIX.—*The Solar Atmosphere, an introduction to an account of researches made at the Allegheny Observatory;* by S. P. LANGLEY, Director of the Observatory.*

IT has long been observed that the sun is not everywhere equally bright, but that the edge is darker than the center, and since a self-luminous sphere should appear of sensibly uniform brilliancy, so as to present to the eye the appearance of a flat disc, this diminution of light must be due to some medium external to the photosphere. Accordingly, even before the invention of the spectroscope, it was admitted that an absorbing atmosphere surrounded the sun, and that the effect would necessarily be to diminish the amount of radiation. La Place, in the tenth book of the Mécanique Celeste, has attempted to compute the total effect of this absorption, from data furnished by the observations of Bouguer, and considers that, were the solar atmosphere removed, the heat and light would be twelve times as great as at present. Though this value is erroneous, being deduced from imperfect data by processes which rest on a false hypothesis, it may yet serve to call attention to the importance of a somewhat neglected field of research, in which this Observatory has been in part occupied during the past three years.

Several estimates of the absorptive power of this atmosphere have been made, differing widely from each other. According to that of La Place, just cited, the absorption is about $\frac{11}{12}$ of the sun's emission; according to Liais less than $\frac{1}{12}$; according to Secchi ·88. These discrepant results may be due in part to different hypotheses used in computation, but they are in every

* Paper read at the Detroit meeting of the American Association for the Advancement of Science.

case founded on an experimental comparison of the light or heat of the sun observed at the center with that observed near the edge.

This direct comparison of the two lights involves, of course, no hypothesis, but is simply a photometric measurement, and apparently an easy one. Let us examine the result of this comparison at different hands. Arago,* using the Rochon prism and analyzer, announced, as the conclusion of a prolonged research, that the light at the center of the solar disc must be diminished by $\frac{1}{41}$ part, or 2·4 per cent, to equal that of the edge. Liais in a memoir † which is a model of conscientious care, announces, from comparisons carried on by the extinction of one light by a stronger, that the central light should be diminished by about 10 per cent, to equal that of the edge. His result is then four times as great as Arago's. Secchi with a wheel photometer, finds, for a nearly corresponding point, 78 per cent as the amount by which the central light should be diminished. This result is then *seven* times that of Liais and *thirty* times that of Arago.

Secchi has made observations on radiant heat to be found in *Le Soleil*,‡ the most important results of which are that the heat diminishes from the center to the edge; that for a given point there is a satisfactory agreement between the absorption of light and heat; and that the equatorial regions are hotter than the polar. The present writer has made somewhat extended researches in the same direction which are chiefly unpublished. Vogel has made interesting researches in the relative actinic absorption.

None of those who have attempted to compute the amount of the solar absorption appear to have drawn conclusions from their results as to its effect on terrestrial temperatures, and yet if the absorption be anything like what has been found by La Place, and by Secchi using La Place's formulæ, the subject deserves attention.

It will be shown in a forthcoming memoir that the absorption is much less than these values, but that definite limits can be assigned in which it must lie, and that at any rate it is of such importance that the conditions of animal life upon this planet largely depend upon it. It will further appear probable that with a slight change in the depth and absorptive power of this atmosphere, fluctuations in terrestrial temperature will ensue, very great in comparison with any actually observed within historic periods, and it will be shown that this atmosphere is not in a strictly stable condition. Though the subject

* Oeuvres Complètes, Tome i p. 235.

† Memoires de l' Académie de Cherbourg.

‡ Le Soleil, 2me edition, Paris. 1875.

then is a nearly neglected one, and the methods of investigation of less apparent interest than those of the spectroscopist, the results are, if verified, of a peculiar interest, from their bearing upon the possible changes in the mean temperature and climatic conditions of our own planet.

The portion of this atmosphere chiefly concerned in absorption I have been led to believe from several considerations is extremely thin, and I am inclined to think it is nearly identical with the "reversing layer" at the base of the chromosphere observed by Secchi and Young, though the other chromospheric strata doubtless, have some share in the obscuration made, and, in a still less degree, the other solar envelopes.

The methods used for heat measurements at Allegheny have been partially described,* and need not be enlarged upon here. Those for light are believed to be novel in their present application, and may be given briefly.

We have seen that a photometric comparison of the center and edge of the sun is for some reason attended with risk of error which we should not anticipate, but which must be great from the enormous discrepancies existing among practiced observers; for, taking Arago's value as the standard, Liais' is four hundred per cent, and Secchi's three thousand per cent greater. Now skilled observers, in comparing their estimates of the excess of the light of a gas flame over that of a candle, for instance, by the familiar methods of ordinary photometry, need not be expected, as common experience shows, to commit errors which are in any way comparable to these.

If such familiar means as the Rumford and Bunsen photometers could be used for the *direct* comparison of the solar intensities there seems no reason why the results should not be of the exactness obtainable in the physical laboratory, or at least of the same order of accuracy. If results can be obtained by such means, they may at least be hoped to be free from gross error.

At first sight it appears that these methods are not applicable to the direct comparison, for the ordinary use of either photometer supposes that the relative distances of the lights from the screen can be altered, while we cannot change the relative distances of the lights to be here compared, which are two portions of the sun; and, if we attempt to enfeeble the stronger lights by shades, or by diffusing it through a lens till it equals that of the other seen direct, we lose the peculiar advantages of the methods which assume that the lights are viewed under the same conditions and measured by the relative distances from the screen.

I arranged, in June, 1874, an apparatus which appears to be free from these *objections*, and which is here described in

* Comptes Rendus, May 22, 1875.

principle, not in detail. Let us suppose that to the equatorial is attached a screen upon which is described a large circle whose radius is divided into 100 equal parts, and whose center is always in the prolongation of the optical axis. This screen receives an enlarged solar image from an amplifying lens. To fix our ideas we may suppose that the circle and image are each always 24 inches in diameter, and that a direct comparison is to be made of the light of the center with that of a point $\frac{3}{4}$ of the way from the center to the western edge of the sun. Two small* and equal circular apertures are made in the screen at points equidistant from the center or 75 divisions of the scale apart. The telescope is directed to neither point under examination, but to a point of the solar disc $\frac{3}{8}$ of the way to the western edge from the center, and which is therefore midway between the points to be measured. The image of the center now falls on one of the small apertures in the screen; that of the point under examination on the other, and through the apertures pass two cones of rays each slightly divergent, formed under precisely the same conditions, since they come from the same lens and are equidistant from the optical axis. Two prisms of total reflection (cut from the same piece of glass) are placed one behind each aperture, and these deflect the rays toward each other, so that the reflected portion of the cones have a common axis behind and parallel to the screen, within a chamber which is lined with black and shielded from light, so as to form in fact a camera obscura. There is a small Bunsen disc behind the screen and in the camera, whose center remains in the axis common to the reflected cones as it (the disc) slides back and forth on a graduated scale which measures the distance from the source of illumination. Evidently one light is diffused and the other concentrated by the disc's advance and recession upon the cones, sensibly as though these were formed by lights at their virtual apices beneath the screen, and by lights which were of the color and intensity of the portions of the sun under examination. In practice it is found convenient to introduce a lens of short focus between each aperture and its reflector, so that the cones, while still exactly similar, may be less acute. By the substitution for the Bunsen disc, of a small box, sliding also on the graduated scale, and containing a rod whose shadows are cast, by means of a second pair of reflecting prisms, on a prepared surface, sliding with the box, we convert the instrument into a Rumford Photometer, and in this form also it has been much used here. This application incidentally permits under very favorable circumstances a comparison of the *color* of the light from different parts of the sun, which is by no means uniform. When light

* The diameter of the aperture is on the above scale about 0″·10.

from near the edge is juxtaposed with that from the center, the shadow illuminated by the former is chocolate-red,* while that from the latter is a peculiar bluish tint, nearly like that given by the shade-glass called by English opticians "London Smoke." (I use these comparisons not being able readily to assimilate these colors to any of the pure spectrum.) It is worth while to remark that this observation confirms others obtained from different means by the writer who has elsewhere announced the fact of a selective absorption in the solar atmosphere of such a nature that were the envelope removed the gain in light would be greater than the gain in heat. The light we receive from the sun and universally call "white" is thus seen to be, upon the whole, less refrangible than that which the sun would emit if deprived of its atmosphere; in which case it is evident that the color of our luminary as it grew brighter would tend toward *blue*. If then the depth of its atmosphere were sufficiently increased, our sun, in growing darker, would also appear more *red*. To more than suggest the possible influence of such a cause on the colored stars, among which the bluish are distinguished by the absence of absorption spectra, and the desirability of ascertaining whether change in color, if any such are verifiable, are or are not accompanied by slight changes in apparent magnitude, would lead us away from the present subject.

So clear an exhibition of color in the actual comparison is a sign of the delicacy of the Rumford method, but it introduces a disturbance in our estimation of the intensities of colored lights. An arrangement of the Masson photometer (in which black and white sectors on a rapidly revolving disc illuminated by the colored lights are viewed by the intermittent electric discharge) has been prepared to obviate this; but the complete examination is intended to include that of juxtaposed spectra formed from the lights under examination, selected portions of which of different wave lengths will be compared, as regards intensity, by processes which are a development of those mentioned above. In all such comparisons the apparatus is reversible, so as to eliminate any inequalities in the material, position, or condition of the rays under examination due to the instrument; and in practice corrections for every form of instrumental error are applied which are not here mentioned.

The methods above indicated are, with some slight modifications, evidently adapted to the comparison of the light of the sun-spots, and the light adjacent to the limb, with that of the center; to studying the rate of diminution of light without the disc, and to like investigations; and they are now being so used.

* This color appears to have passed unnoticed by all observers but Secchi, who remarks that the edge of the disc is smoky-red.

Without entering into detail, I may observe that the measurements of the light of spots, though as yet incomplete, warrant me in stating that the absorption of the more refrangible rays, though great in reference to the less refrangible, is not so great as would appear from published measurements. It has long been supposed that the umbræ of spots were not absolutely dark, while it has been admitted, from Dawes's observation, that there is within the umbra a sensibly black "neucleus," and from the assumed blackness of this "neucleus," several astronomers have been led to suppose that the "neuclei" are not openings into a dark gaseous interior.

The measurement of umbræ, and of so-called "neuclei" here shows not only that neither are absolutely dark, but that the absolute light of either is enormous, that of the average "neucleus," so-called, being, as I find, at least *five thousand times* that of the full moon.

La Place, in assuming that the radiation in any direction is constant, and is proportional to the radiating area (or that the radiation is infinite at the edge of the disc), concludes that the total absorption is represented by the integral

$$2\pi\int_0^1 \varepsilon^{-\frac{1}{\cos\theta}} \sin\theta d\theta$$

where θ is the heliocentric angle between the earth and the point of the solar surface under examination; and this assumption has been adopted by Father Secchi, who, in his latest edition of Le Soleil, gives results derived from the use of this integral. I shall, however, assume, in accordance with what seem to be the teachings of modern physics, that a globe as large as the sun whose photosphere, though composed perhaps of very light vaporous material, is yet opake at a limited depth, (as observations on superposition of cloud-strata have shown) that in such a globe radiation would be proportional to the cosine of the angle between the normal to the surface at any point and a line drawn from that point to the observer's position; or, that the sun, deprived of its atmosphere, would appear as a flat disc; whence it will follow that, the total radiation of the sun without the atmosphere being unity, that which escapes through the atmosphere will be, if we adopt La Place's formula with this correction, $2\pi\int_0^1 \varepsilon^{-\frac{1}{\cos\theta}} \cos\theta\sin\theta d\theta$.

These expressions, if La Place's assumptions are otherwise correct, should give, for any comparison of the heat at a given point of the disc to that of the center, a certain value of the absorption which should be constant for any value of θ. In fact I find, however, that this is not the case. The discrepan-

cies in the summation I obtain for different values are not however casual and irregular, as they would be if due to errors of observation, but are systematic. This formula even as here modified, though analytically speaking correct, yet appears to rest on assumptions which are in disaccordance with facts ascertained since La Place wrote. These facts, as they seem to me, demanding a changed formula I expect to point out in a definite form in a subsequent memoir. It seems fitter then to defer an exact statement of the limits of the amount by which solar radiation is absorbed by the atmosphere, until it is accompanied by demonstration. I will only here repeat that we may feel certain that the estimates cited from La Place and Secchi, and which make the sun's atmosphere absorb from $\frac{7}{8}$ to $\frac{11}{12}$ of the radiation we should receive in its absence, are in excess of the truth. For the sake of indicating approximately the real value, I may also state that from my computation of the so-called "luminous-heat" rays, not greatly less or more than one-half the whole are absorbed by, turned back by, or converted into work in, the sun's atmosphere. The total thermal absorption is somewhat less than that of the luminous heat. If, however, we admit this value provisionally, certain results seem to follow which deserve mention.

The mean surface temperature of our globe is separated from that of absolute zero by about 500° of the Fahrenheit scale. The internal heat supplied to the surface may be neglected. The temperature of interplanetary space is, according to Fourier −60°C., according to Pouillet −142, according to Liais −97. Liais, in a memoir whence we cite these estimates, admits, as a consequence of his own, that the obscure heat received at the upper limb of our atmosphere from space (that is, from the chiefly non-luminous matter which occupies it) is greater than that furnished directly from the sun, a conclusion which we are not called upon here to adopt, further than to observe that with this, as with either of the other estimates, the obscure heat received from interplanetary matter by reflection from the sun at the surface of our atmosphere is considerable, so that, if our luminary were wholly extinguished, the temperature of the earth would fall much below that it would reach if only the direct solar heat were withdrawn.

We shall perhaps be warranted in entertaining it then as a reasonable assumption, that, in the complete absence of the sun, the earth's temperature would fall very nearly to −273° C. We prefer as the basis of an estimate, confessedly but approximate, to take the mean of this value and Pouillet's, and, using the Fahrenheit scale, we may state that of the 500° F., which on the natural scale is the approximate mean temperature of our globe, as much as *four-fifths* is derived from the sun.

If it be true then that the sun is surrounded by an atmosphere whose principal action in obscuring the heat radiation is due to a thin stratum which cuts off one-half of the heat which should reach us, and in whose absence this radiation should be doubled,—an atmosphere not independent of the interior of its globe in such a degree as our own, but one to and from which matter is constantly being added and withdrawn,—it follows that any change in the ratio of supply and withdrawal, or other cause, which should increase its absorption by so much as 25 per cent would diminish the mean surface temperature of our globe by 100° F., whilst a like diminution in the envelope would produce a corresponding change in the opposite direction.

I am unable to see that, if the Allegheny observations are correct, whence I have derived the above given approximate value of the absorption, any other result would follow, and in any case the existence of life in its present forms on this planet seems dependent, within certain limits, on the depth and absorptive power of the solar atmosphere. The reader who may not have closely observed how far the validity of this result is dependent on, and how far independent of, the hypothesis just made as to the mean terrestrial temperature, is invited to remark that there is nothing hypothetical in any case in the assertion that the earth would fall, in the absence of the sun, to a temperature as low as any actually observed on its surface. If any value attach to the writer's measurements, then, it will be found from a repetition of the calculations with (arctic) temperatures *actually observed*, and hence within the truth, that the result remains that a comparatively slight thickening of the solar atmosphere, or an increment of its absorptive power by as little as $\frac{1}{4}$, would bring the planet back to what we must suppose were the temperatures of the glacial epochs.

Father Secchi seems to think it probable that the difference between the measurements of the heat at different portions of the solar disc made at Rome in 1852 and at Allegheny in 1873-4 are explicable by a real change in the atmosphere of our luminary. To the writer it seems that such a change as Father Secchi assumes, if real, is (if interpreted by Father Secchi's own formulæ) likely to have already altered the mean annual temperature of the earth to an amount sensible to every inhabitant of its surface. He is himself, therefore, of the opinion expressed by M. Faye that no evidence of real variation has yet been established.

It will not of course follow that changes may not take place in cycles of time long with reference to historical periods. All analogy leads us indeed to think an absolute uniformity most improbable.

Finally, then, it appears that though we are justified, on grounds established by Helmholtz and Ericsson, in believing in the constancy of the heat-supply *within* the solar envelope for periods to come which are with reference to our terrestrial past almost infinite, we are not justified by our present investigations in asserting that the solar radiation has been constant during geologic periods, or is certain, or even likely to remain, what we now see it during corresponding periods in the future.

If there be great cyclical changes of long period (and in our present ignorance we can only say that such are not antecedently improbable) there will be corresponding changes in terrestrial temperature; and it is allowable to inquire whether we do not find here matter for consideration in connection with those great changes of temperature in past epochs which have in them nothing hypothetical, which geology assures us have indeed existed, and for whose possible cause no satisfactory suggestion has hitherto been made.

ART. LX.—*On Southern New England during the melting of the Great Glacier.—Supplement: The Overflows of the flooded Connecticut;* by JAMES D. DANA.

IN the remarks on the occurrence of Reindeer remains in the vicinity of New Haven, on page 356 of this volume, I have stated that the reindeers must have been living in the Quinnipiac valley after the retreat of the glacier and before the glacial flood; and on page 425 it is shown that the New Haven rivers must have had their floods from the melting glacier greatly prolonged by accessions derived from overflows of the Connecticut. It is evident that such overflows would have had an important influence on the geology of Southern New England, and I therefore present here the evidence I have been able to collect with regard to their positions and courses.

But, by way of introduction, I first mention some particulars from the older geological history of the great central valley of New England, since they serve to explain in part the occasion of these phenomena in its later history.

I. THE CONNECTICUT VALLEY BEFORE THE GLACIAL FLOOD.

It is well known that, in the Triassic period, and probably also the Jurassic, the Connecticut valley, from New Haven to Northern Massachusetts, was occupied by a brackish-water estuary—its length over 110 miles, its width for the most of the way 20 miles or more. Farther north, the valley for a long distance is narrow, and here the waters were probably those of a true

river. The sides and bottom of the estuary were of crystalline rocks, similar to those outcropping over the bordering region. The sand-flats and mud-beds that were made in the great estu ary, out of the material contributed from either side by rivers of the era, constitute its Red-sandstone formation.

The red sandstone of the area is now 300 feet above sea-level near New Haven, and over 1300 in Massachusetts fact showing that, since Jurassic times, New England has b raised over its center at least a thousand feet more than al its southern coast.

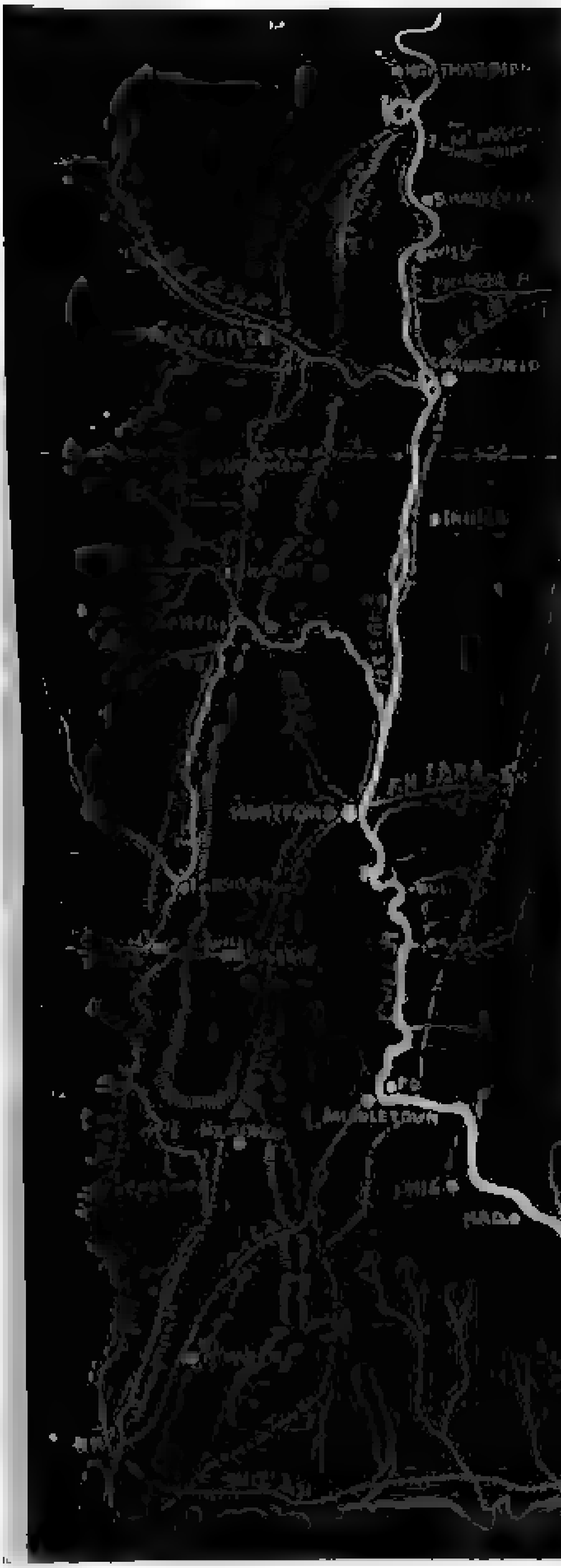
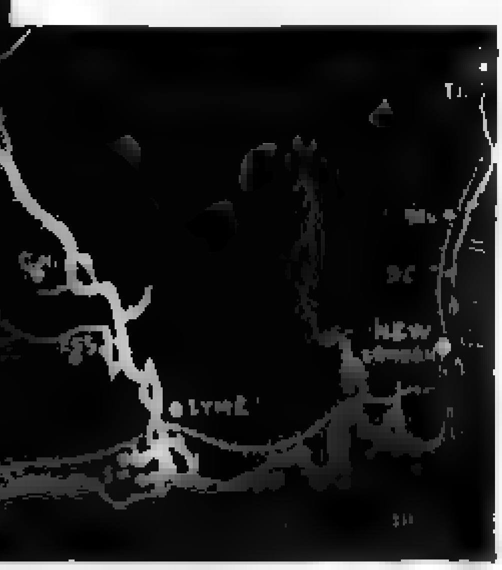
With the exception of the seaward slope thus occasion and the erosion by denuding waters, the area of the Tria sand-beds might have remained till now a wide plain, with river of the valley flowing through it in a deep channel of own making, and emptying into the Sound at New Haven, it not been that the deposition of the beds was followed, o the whole area, by subterranean movements that ended in ing them, making numberless long fractures to unkno depths, and filling the fissures so opened with melted ro The sandstone was by this means left intersected by dikes trap, along with adjoining hard-baked portions of its own be which could stand wear a hundred fold better than other pa of the formation: and, as erosion went forward, the trap di became the trap ridges of the country, standing, with some the enclosing indurated sandstone, as high barriers betw different parts of the sandstone area.

A prominent line of these trap dikes divides the area, in north-and-south direction, from Mount Tom (1214 feet high) near Northampton, Mass., to West Mountain (996 feet high) three miles northwest of Meriden; the valley is thus divided into an *eastern* and a *western* section, the former three times the widest. This range is called in the following pages, the Mount Tom Range, and also Divide Range.* This range is continued south of the Meriden hills in a low ridge of sandstone to Mount Carmel (736 feet high); then, by another lower ridge of sandstone to East Rock (360 feet high) nearly abreast of New Haven city.

For the convenience of the reader of this and other recent papers on New England geology, by the writer, a map of the

* This line of ridges from New Haven to Northampton was called the Mount Tom Range by President Timothy Dwight in 1796 (Travels, p. 5). Looking only at the general features of the country, he made this range a branch from the White Mountains, and the elevations of Western Connecticut, commencing at the West Rock trap range near New Haven, he spoke of as a part of the Green Mountains. The error was not a bad one in 1796. But it has been reproduced since in geographies, encyclopedias and gazetteers, and recently it has appeared in a school book of Connecticut origin and in a Guide book for the Connecticut Valley. It is alluded to here in order if possible to stop its further circulation. Over 50 years since, Professor Silliman corrected the error in this Journal, and yet it still survives.

MAP OF THE CONNECTICUT VALLEY AND PART OF THE COAST OF SOUTHERN NEW ENGLAND.

The Triassic area on this map is the part between the dotted lines on the right, and the line of slopes M, M, M, on the left.

ABBREVIATIONS.—In *Massachusetts*, WILLT., Willimansett; B. & R. R., Boston and Albany Railroad. In *Connecticut, west of the Connecticut River*, SB., Simsbury; W., Westville, at the foot of West Rock; N. H., city of New Haven; N[h]. HAVEN, North Haven; SR., south of New Haven, Savin Rock. *On the Connecticut River*, WO., Windsor Locks; GL., Glastenbury; S.GL., South Glastenbury; MANCH., Manchester; PD., Portland; HIG., Higganum; HAD., Haddam; CH., Chester; ESS., Essex; SK., Saybrook. *On the Thames River*, N., Norwich; TH., Thamesville; MV., Montville; SC., Smith's Cove. *Railroads*, AIR L. R. R., Air Line; N. H. & H. R., New Haven and Hartford; N.H.&N.R.R., New Haven and Northampton, or Canal; SH. L. R. R., Shore Line.

Connecticut valley and part of Southern New England is h annexed.

These trap barriers naturally determined to a large ext the drainage-lines of the area. Since the eastern section three times the widest, and the freest from dikes of the f made rock (trap), it is not strange that it became the cou of the Connecticut River. But south of Hartford, betw that city and Meriden, a succession of trap ridges rises to east of this range, which crowd toward the river; and, con quently, the Connecticut, after passing Hartford, loses westing; and then, at Middletown, where the metamorp rocks are near in high elevations, turns abruptly out of its valley through an opening heading southeast that then offe no doubt an unobstructed way to the Sound. Thus the south part of the valley lost the Connecticut River. This event New England history occurred before the Cretaceous peri After this, geology has no special facts from the valley until Glacial period.

The western section of the sandstone area, shows that it w too contracted to become the course of the Connecticut by subdivision into many river basins. The Northampton regi is divided from the Westfield, and the Westfield from the Far ington. Moreover, the Farmington, while essentially c valley in its plains from Granby to New Haven, fifty miles, l three prominent rivers in this distance. Farmington river, t largest of them, makes a long V-shaped bend in the valley, fi south and then north (as the map on p. 499 shows), and fina flows off into the Connecticut valley through a gap in t Divide Range near Tarifville. The eastern arm of the V lies the broad flat meadows of the valley, with no ledge or hill prevent the river's pushing southward instead of northwa In that same low plain, not two miles distant from the sou

of higher level than now with the elevation increasing northward. The red sandstone of the valley is a soft rock, yielding easily to abrading agents; and through its removal the trap ridges of the valley may then have derived the larger part of their prominence. From the height above the Connecticut flats of the sandstone ridge called Mount Toby (or Mettawampe) in Sunderland, about thirteen miles north-northeast of Northampton, we learn that not less than 1200 feet of rock in depth has been removed from the sandstone formation of that part of the valley since the Jurassic period, of which a large part was probably the work of the Glacial era; and, on the same kind of evidence, that the removal near New Haven has exceeded 300 feet.

II. The Connecticut Valley during the Glacial Flood.

In the next or Champlain period, when the land had subsided, and most deeply so to the northward, and when the melting of the glacier had far advanced, the valley was put under new conditions, as has been already explained; and, according to the evidence mentioned beyond, New Haven Bay was restored in part to its old rights by overflows giving it some of the surplus waters of the flooded Connecticut.

The height of the flood from the melting glacier as illustrated in the last number of this Journal, from the height of extensive terraces of stratified drift—was such that, at Middletown, the waters, instead of stopping at 24 or 25 feet above low-water mark, as now, continued rising until 175 feet deep; and from that level, they went plunging down the narrow channel to the Sound; that, at Hartford, the river rose above the modern 30-foot flood-level to 190 feet; that, at Springfield, they reached a height of more than 200 feet above low-water mark, and 240 feet above mean sea-level.

It admits of proof, further, that when the flood was at its height, the Connecticut overflowed in at least three places, westward, into the western section of the valley, and there flowed southward to New Haven Bay. These three places are—

First, over the Meriden divide, as has been already explained.

Second, at Westfield, west of Springfield, whence the waters descended along the western section of the valley, and finally joined Quinnipiac and Mill Rivers—New Haven streams.

Third, from the Northampton region, by the valley west of Mount Tom, over the Westfield divide to Westfield, there to join the Westfield overflow.

As to other westward overflows to the north I do not speak, as I have made there no special examinations.

The fact and the features of the western section of the val-

ley have been long appreciated. So early as 1822 it w selected as the route for a canal from New Haven to Northam ton, to be named the Farmington canal, which by 1835 was fi ished; and in 1847 the route of the unprofitable canal w taken for a railroad, called the New Haven & Northampton, Canal, Railroad. Prof. Hitchcock, after an examination of map and section of the canal, queried why the Connectic river had not made for itself a channel along that route, rath than the more eastern; and in his "Surface Geology" he d scribes that section from Northampton to New Haven a branch of his "second basin" of the Connecticut valley.

On page 140 of Prof. Hitchcock's first Geological Report Massachusetts (8vo, 1835), and p. 329 of the second edition (4 1841), he has the following remark: "In tracing the Connectic through this [its] valley the geologist will be surprised to find crossing the greenstone ridge above described, and that too at i highest part, viz: through the gorge between Holyoke and To For he will naturally inquire: Why did not the river flo through the valley *west* of the ridge, and, following the course the Farmington Canal, empty at New Haven? for it appears fro the surveys on this canal, that in no place is that portion of t valley more than 134 feet * above the present level of the Connec cut at Northampton, whereas the trap ridge through which passes is from 800 to 1,000 feet high.

The denudation required for "crossing the greenstone [tra ridge" appears less difficult when the fact is recognized that M Tom and Mt. Holyoke are two independent trap-dikes of very d ferent trends, the latter an east-and-west dike; and that, as seen at the eastern foot of Mt. Tom, along the river, there w sandstone between them; so that it was sandstone that was r moved for the river or by the waters of the valley, and not trap

Prof. Hitchcock says, in his Surface Geology (1857), speakin of the topographical basins into which the Connecticut Vall may be divided (p. 11): "The second basin extends from H

* The survey for the Canal found the greatest height two miles north of We field, between Westfield and Northampton, and made the height of the top of t divide above the level at Northampton, 86 feet, and the height of the latter abo the Connecticut River 48 feet; and 86 + 48 = 134.

† Dr. Percival, in his Report on the Geology of Connecticut, brought out t fact that the trap ridges of the Triassic area are often made up of two or mo trap-dikes separated by sandstone; that is, are formed from the fillings of two more independent fractures—independent at least at surface. Pine Rock, a tr ridge east-northeast in trend (like Mt. Holyoke) in the New Haven region on the map of p. 415), appears as if it were a continuation of the south end West Rock, which turns toward it, and still they are wholly distinct; and Pi Rock, although not half a mile long, is actually a combination of four masses dikes of trap with sandstone between, and a third of the length is sandsto Again, East Rock (E. on the same map) consists of three dikes with interven sandstone. It is owing to this composite character that gaps through the hi trap-ridges are not uncommon. The associated sandstone, while generally ha baked, is sometimes cracked into small chips as a consequence apparently of t *dry* heat in the baking.

yoke to Mettawampe (Mt. Toby) in Sunderland and Sugarloaf in Deerfield. From Holyoke this basin must have extended southerly along the *west* side of Mt. Tom and the other trap ranges that extend almost continuously to New Haven. Through this valley runs the Canal Railroad, but nowhere is this valley more than 134 feet above the Connecticut at Northampton, and this is not so high as some of the terraces."

The idea here conveyed is expressed also on the map of the Connecticut Valley, forming plate III, of the same volume. A terrace-plain, numbered 2, is made to spread southward from Northampton, or rather from Greenfield more than twenty miles north of Northampton, through Southampton, Westfield and Southwick in Massachusetts, and Granby in Connecticut. The map, however, presents a suggestion of the author's mind rather than a fact at the time established: for terrace No. 2 of Northampton, the highest mentioned for that place, is according to the text, only 97 feet above low water in the river instead of 134 feet, which makes it nearly 40 feet too low to pass over the divide to Westfield.*

Further, it is necessary to note, in order to apprehend Prof. Hitchcock's views, that in discussing the origin of terraces in the same work (p. 49 and beyond) he makes the ocean a chief agent in producing "beaches and terraces," and supposes a submergence of the land of 2,000 to 2,500 feet (pp. 53, 54), attributing part of the effects to icebergs, marine erosion, and the making of seashore beaches and flats during the period of submergence and during a progressing emergence, and part to the drainage which was again set in action by the emergence. In his Geological Report (1841) he makes the terraces a result of river erosion. The terraces of the Connecticut Valley, in the view I have presented, are wholly of fluvial origin, and the highest terraces of the various valleys, whether over the lower or higher parts of the country, are approximately measures of the flood-level in each.

The proof with regard to these westward overflows is derived from the terraces of stratified drift over the regions.

1. *Overflow at the Meriden divide.*—On this overflow it is necessary here only to repeat in brief the facts from page 425

* The numbers affixed to terraces by Prof. Hitchcock, in his Surface Geology, express the succession at a locality, beginning with the lowest as No. 1: so that terraces of different localities that are the same in height have often different numbers. The Northampton region has only two terraces, numbered 1 and 2, respectively 57 and 97 feet above low water in the Connecticut, and the latter stated to be 202 feet above the sea-level. At Whately, half a dozen miles north, there are three, Nos. 1, 2, 3, respectively 32, 46 and 92 feet in height, the last 206 feet above the sea-level, and therefore the same with No. 2 of Northampton; yet this No. 3 has a different color on the colored map. No. 2 at Greenfield, a dozen miles farther north, is 291 feet above the sea-level, and therefore different from either of those at Whately or Northampton. This feature of the work has to be noted in order rightly to apprehend the facts it presents.

Prof. Hitchcock also has "moraine terraces" and "sea beaches" among the phenomena of high levels over the country—which I have been led to regard as mostly terrace-formations at high levels where there were water-courses during the era of the melting glacier, if not so now.

of this volume: that the divide 1½ to 2 miles north of Meriden, is on the borders of the Hartford river-region: that the highest part of the divide is near the Hartford flood-level, about 160 feet above modern high water in the river; and that over 20 feet of terrace sands and gravel, that is, stratified drift, underlies the summit plain. The red sandstone outcrops in some places over the top and rises into ledges. The overflowing waters eroded the sandstone surface, and descended to the Quinnipiac, just below Meriden, to swell the stream and increase the height of its terrace depositions.

2. *Overflow from Westfield, Mass., over the Southwick divide, into the Farmington Valley.*—The village of Westfield is situated nine miles west of Springfield, on Westfield River, a large and rapidly flowing stream tributary to the Connecticut. The river emerges from its confined valley of metamorphic rocks, about twelve miles west of the Connecticut River, at "Mt. Tekoa," and there enters the open Red-sandstone area in which Westfield is situated. Five to six miles west of the Connecticut, it passes through a gap in the Mt. Tom or Divide Range, and enters the present Connecticut Valley. The Westfield region is hemmed in on the north by the Westfield divide, between it and Northampton, and on the south by the Southwick divide, separating it from the Farmington Valley—both made of red sandstone, but having, over the sandstone, levelled deposits of stratified drift.

The upper terrace of the region extends from the city of Westfield three miles westward.* The material is sand and

* See a colored map of the Westfield terraces in Hitchcock's Surface Geology, Plate VII. The author expresses his doubts with regard to the heights he gives. His No. 4 corresponds nearly with the lower part of the upper terrace as measured by Mr. Dunham. The region along the course of the old Farmington canal, from New Haven to Northampton, was surveyed for the canal-route by Mr. H. Farnam, then Assistant Engineer, and in charge of the work. The section published on a map engraved by Messrs. N. & S. S. Jocelyn, of New Haven, in 1828, gives all the lockage to Northampton, and, in fact, beyond this to White River Junction, its projected termination. The section makes the water level of the canal over the Southwick divide, through the Southwick Ponds, 220 feet above mean sea-level; at Westfield, alongside of the present Railroad Station, and nearly on a level with the track, 144.75 feet; over the Westfield divide, 230.75 feet; at Northampton, 48 feet above its termination at water-level in the Connecticut, 144.75 feet. Mr. Farnam informs me that the plain of the Southwick divide was as I had estimated, about 20 feet above the level of the Ponds, and thence about 240 feet above mean sea-level; that of the Westfield divide, about 10 feet above the level of the canal, or 241 feet. As bearing on these levels I state further that according to the surveys of the Connecticut River, under Gen. T. G. Ellis, the height of the railroad track at the Springfield Station is about 70·4 feet above mean sea-level. Mr. H. F. Dunham, assistant in the office of the City Engineer, Springfield, obtained, in a careful levelling from Springfield (obligingly made for this place), 148.84 feet for the level of the track (top of rail) at the Westfield Station. He judged that the water-surface of the canal was probably 2½ feet below the same level. By adding 53 feet (from R. R. levelling) to 70.4 gives 123.4 for the height of the track at the Northampton station. But according to Mr. E. C. Davis, Civil Engineer in Northampton, the track there is about 19.3 feet below the level of the old canal.

gravel, as usual—with the gravel, at the section I examined in the city, constituting the upper 25 feet, excepting 2 or 3 feet of sand at top. According to a levelling by Mr. H. F. Dunham (assistant to Mr. G. A. Ellis, of Springfield,) the height near its eastern limit is about 239 feet above mean sea-level; and from this it gradually rises westward—or up stream—to 286½ feet. The 239-foot level is very near that of the highest flood about Springfield (240–245 feet); it is about 96 feet above modern flood-level in Westfield River.

The proof that the waters of the flood passed the Southwick divide into the Farmington Valley is as follows:

1. The upper terrace plain of the divide is not above the height of the upper terrace plain of the Westfield region.

2. The Southwick Ponds, which lie along the lowest part of the divide, where it was passed by the Farmington Canal, are lower than the lower level of the upper Westfield plain.

3. The terrrace plain of the divide may be followed down the Farmington Valley.

On the 1st and 2d of these points I observe that the height of the Southwick Ponds is about 78 feet above high water in Westfield River, or 220 feet above mean high tide—which is nearly 20 feet below the lower part of the upper Westfield terrace. A terrace bordering the ponds carries the height up to about 240 feet. The level rises to the northwest over the Southwick plain: but there, along the railroad track, the height is but 260 feet, which is 25 lower than the higher part of the Westfield terrace.

We may hence conclude that before the flood exceeded in height 220 feet, the flow southward had begun; and that as the waters rose the terrace deposits above that level were laid down over the divide. Since 240 feet was also the height of the highest terrace on the Connecticut east of Westfield, the waters of the overflow may have been in part those of the Connecticut; but it is probable that they were solely from Westfield River—waters which the Connecticut was thus deprived of; for the height of the flood over the middle of the Westfield basin was at least 275 feet, as shown below, the waters having been held up to this level (30 feet above their height at Springfield) in consequence, probably, of the narrow passage for them below Westfield through the Divide Range.

As to the third point, I give the following table of heights of the upper terrace along the valley south of the divide—the terrace plain in each case, the first excepted, being extensive.*

* The terrace at Tarifville rises at first abrubtly, near the railroad station, and afterward with a slope which extends beyond the cemetery; the deposits are of fine earth, excepting the upper 20 feet which are pebbly. The top is not clearly defined, but appears to be indicated by the pebbly beds. The Simsbury terrace is an elevated plain, directly west of the railroad. There is an extensive plain about

	Distance south of the Divide.	Height above flood-level.	Height above mean sea-level.
Tarifville	$8\frac{1}{2}$ miles.	115 feet.	275 feet.
Simsbury	12 "	110 "	270 "
Farmington Station	22 "	80 "	254 "
Plainville	26 "	49 "	234 "
Southington	$30\frac{1}{2}$ "	75 "	223 "

The facts show that the flood had a height over the Southwick divide of at least 270 feet; that this level was kept up as far south as Tarifville and Simsbury by the inflow of the flooded Farmington; that south of Simsbury the decline in height was very gradual; and that even at Plainville, where the flat valley spreads to a great width, the terrace was made to a height but little lower than the plain at the divide. At Tarifville, the Farmington is reached and here the waters from Westfield joined those of that river.

The high level at Tarifville and Simsbury is very remarkable, considering the open cut through the Divide Range by which the stream now enters the Connecticut valley, and the fact that the terrace-plain east of the range is full 50 feet lower than that west. But the cut is not 100 yards wide; and, besides, it may have been filled with drift from the glacier (as was the Niagara channel), and the removal of the obstruction have not begun until the flood had reached its height.

Reaching Plainville, the waters left the present Farmington River area, to enter the Quinnipiac; for there was nothing to prevent, all being one plain below; and a Farmington valley terrace 49 feet high continues southward as the terrace of the Quinnipiac. Thence they went down the Quinnipiac Valley to New Haven Bay.

Where the Quinnipiac River, ten miles from its source, below Southington, commences to bend out of the valley, part of the waters joined Mill River—no impediment existing there in hills or ridges; and the upper terrace of the Quinnipiac continuing on down Mill River.

Thus the flooded Farmington, swollen still farther by waters from the Westfield overflow, occupied the whole Farmington Valley from the Southwick divide to the Sound; and the flood discharged into New Haven Bay by two of its streams, Quinnipiac and Mill Rivers.

It is a misfortune to the State of Connecticut that the Farmington River did not take advantage of the opportunity thus afforded to dig a channel deep enough to ensure its permanent flow to New Haven; since, with such a river, the bay would have made one of the best harbors on the New England coast.

the Granby Station at about 210 feet above mean sea level. The terrace measured at Plainville is on the east side of the Farmington Valley, $1\frac{1}{2}$ m. from the railroad station, close by the Quinnipiac. I am indebted to Mr. H. F. Root, Civil Engineer on the Canal Railroad, for heights along the road.

3. *Overflow from the region of Northampton, by the west side of Mount Tom, to Westfield, to join the flow down the Farmington Valley.*—The obstacle here was the divide north of Westfield.

The upper terrace of the Northampton region is one of the best defined terrace-plains of the Connecticut valley. It is only two miles west of Northampton, and is known as the Florence plain, part of it being the site of a village of that name. Its height above mean sea-level, according to the survey for supplying the city with water, as I am informed by Mr. E. C. Davis, Civil Engineer, is 260 to 265 feet. The terrace which Prof. Hitchcock gives as the highest in northern Northampton occurs also just west of the city, though with the surface rising westward; its height he gives as 97 feet above low water, and 202 above tide level; and it is therefore 60 feet below the level of the Florence plain.

The Florence-plain level, 260–265 feet, is evidently a northward continuation of the upper Springfield level, that of 240–45 feet. There is hence a difference of level of 20 feet in a distance of 16 miles. But if the land were depressed, with the depression increasing northward at the rate of a foot a mile, the pitch would have been slight. How far the narrows between Holyoke and Tom affected the height of flood-level above and below, I have not investigated.

From the height of the upper terrace-plain at Northampton, we know that the flood-height there was *not below* 265 feet; and probably it was 10 or 15 feet above this, as Hitchcock mentions a terrace of 289 feet near Hadley. What then was the level of the Westfield divide?

This divide at its lowest part, where it was crossed by the Farmington canal, has a height of but 241 feet above mean sea-level, which is more than 20 feet below the terrace-level at Northampton. We have good evidence, therefore, that the overflow took place, and that the stratified drift of the divide owes to it its deposition. High terraces exist along the sides of the valley between the divide and Northampton.

Passing the divide the waters joined those of the flooded Westfield River; and if so, they became part of the overflow which descended by the Farmington, Quinnipiac and Mill River valleys to New Haven and the Sound.

Conclusions.—(1.) The Connecticut when the Glacial flood was at its height had a depth of 150 feet, or more, all the way from Middletown to Turner's Falls at Springfield—and to an undetermined distance beyond; and from Hartford to Turner's Falls it averaged fifteen miles in width. It was a great stream, fed by numerous headlong torrents from either side; and, at the same time, feeding other streams from its surplus waters. Its depth and extent was in spite of great losses from overflows into other valleys.

(2.) The violence of the flood in the Connecticut valley was confined mostly to the time of its maximum height. At Hartford, Springfield, Westfield, and elsewhere, the coarse deposits have been found to be those of the upper portion of the terraces; not of the upper terrace alone, but often also of the lower, and because the low may be of flood-origin as well as the highest. (This volume, p. 178.) When the Connecticut flood at Springfield was about 120 feet above modern flood-level, or 180 feet above mean sea-level, and at corresponding height northward to Northampton, the waters were sluggish; for clay beds, which could be formed only in sluggish waters, are common through the region up to this level; and with the clays, except at points remote from the river, there are only fine sands—other evidence of the absence of all violence of movement. For the next 20 feet the beds at Springfield continue to be of sand. The cause of such an almost lake-like condition over this region, when the waters were already so high, can be explained only by assumptions, and for the present I let them pass unconsidered. Above the 200-foot level at Springfield, the deposits are generally coarse.

(3.) The facts show that the flood of the New Haven rivers did not cease when the melting glacier had disappeared from their valleys, even if so to their very sources. While the glacier was continuing its retreat to the Massachusetts border, the Farmington River may have been pouring its floods down the Quinnipiac; and during the long retreat through Massachusetts and the States north, both the Quinnipiac and Mill Rivers were swollen with waters from the overflowing Connecticut.

Such conditions have to be taken into consideration in order to study rightly the Quaternary geology of the country, or of any Glacial land. The reindeer bones in the clay beds of the Quinnipiac (this volume, p. 353) indicated, by their position and freedom from wear, that reindeers lived in the valley after the retreat of the glacier and before the glacial flood had reached its height; and we may understand from the above observations how and why this was possible. The conditions of all the rivers of the ice-covered land when at flood height, their depths, widths and overflows, must be worked out and mapped, before the events of the Fluvial or Champlain period in the Earth's history can be fully understood or appreciated.

Correction for page 427.—The narrows below Middletown are 650 feet wide at low water and 800 at extreme high, according to Gen. Ellis (Rep. U. S. Engineer Dept. for 1859), who thus explains the height of the modern floods above.

Des Cloizeaux on the optical properties of the Feldspars, p. 480.—The following errors occur in this article. In lines 3 and 20 from foot of page, 19° 27′ for 15° 27′, and in the bottom line, 7° 12′ for 5° 12′.

Watson's Descriptive Geometry.—The work noticed on page 488 is by Wm. Watson.

GENERAL INDEX

OF

VOLS. I—X, THIRD SERIES.

NOTE.—The names of minerals are inserted only under the word MINERAL. The references to articles on Botany, Geology and Zoology, are grouped under these words, but at the same time are in general inserted in their places elsewhere.

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ERRATA.

The Errata of the volumes 1 to 9 will be found severally in each. The follow-
g are additional.

ol. iii, p. 383, line 9, for i. e., read e. g.; line 44, for first, read e. g.

p. 384, lines 7 to 13 should be transposed so as to follow line 36; lines 36 and 52, for i. e., read e. g.

ol. v, p. 9, line 30, for 65° 50′·3, read 65° 58′·3.

p. 11, line 16, for *cuspidatus*, read *cuspidata*.

p. 15, line 11 of notes, for spine, read spire; line 35 of notes, for *helecina*, read *helicina*.

p. 100, line 18 of notes for *Lyngmanni*, read *Lyungmanni*.

ol. vi, p. 439, line 14, for *Krogeri*, read *Kroyeri;* line 16, for *Nychia cirrosa*, read *Eunoë Œrstedii;* line 24, for *lucida*, read *nitidulum*.

p. 440, line 4, for *sopotilla*, read *sapotilla;* line 9, for *solidula*, read *solida;* last line of note, for 1870 read 1780.

ol. vii, p. 39, line 6 from bottom, for *Ophiocnida hispida*, read *Ophiacantha spinulosa*.

p. 131, line 6 from bottom, for *Pontagenia* read *Pantogenia*.

p. 132, line 9, for *Borlasia sp.*, read *Cephalothrix linearis*.

p. 134, line 29, for *Eurosalpinx*, read *Urosalpinx*.

p. 444, line 37, for A. Chanean, read A. Chauveau.

ol. x, p. 40, line 39, for Cauthouy, read Couthouy.

p. 155, line 42, for E. Sesemann, read C. Seemann.

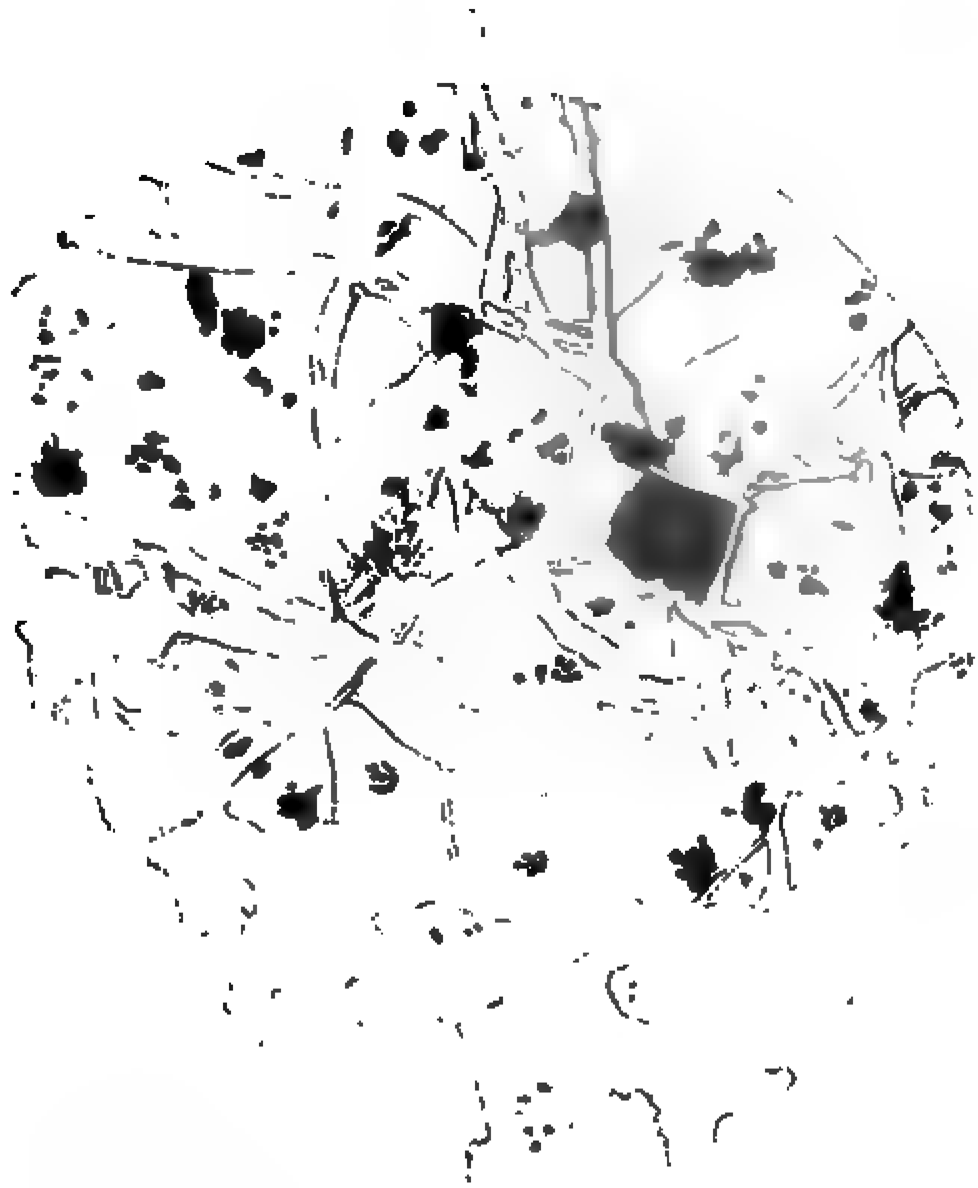
p. 213, line 26, the statement "16 inches in circumference" applies to the basal portion of the short arms.

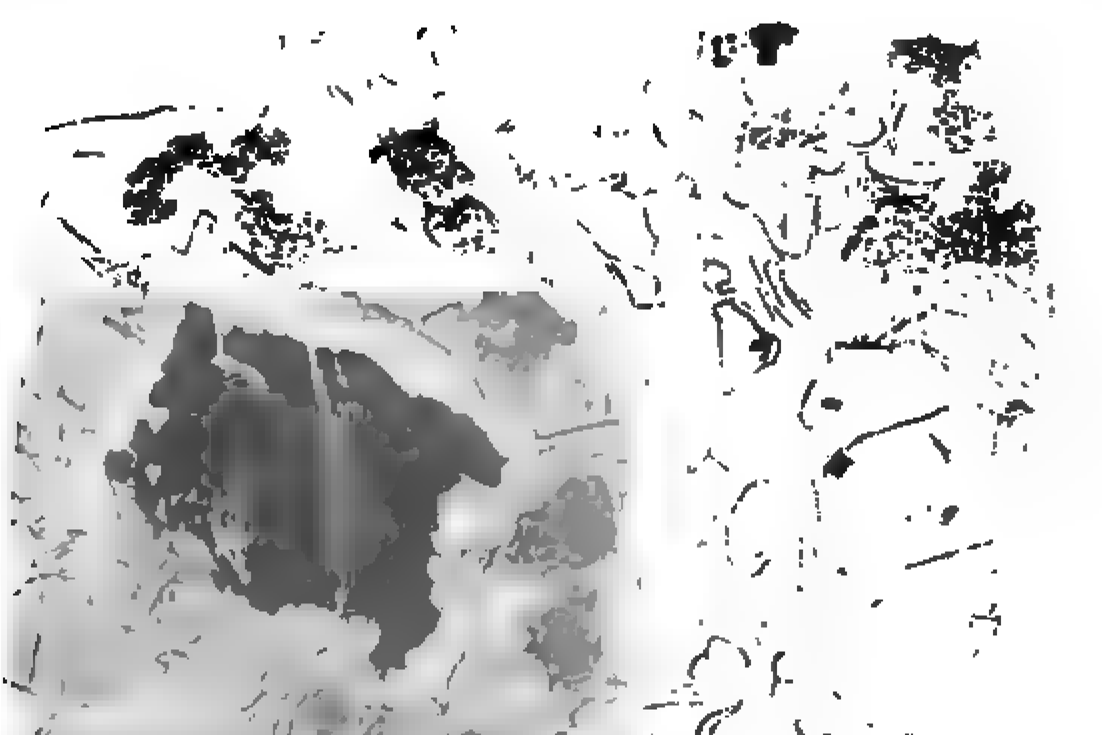
p. 352, in figure, transfer the letter *S* to the knife-edge from which the wire basket is suspended.

p. 427, line 11 from top, for 400 *yards*, read 800 *feet at highest modern floods;* 13th line from top, for 500 to 550, read 400 to 450.

p. 480, lines 3 and 20 from foot, for 19° 27′, read 15° 27′; and last line, for 7° 12′, read 5° 12′.

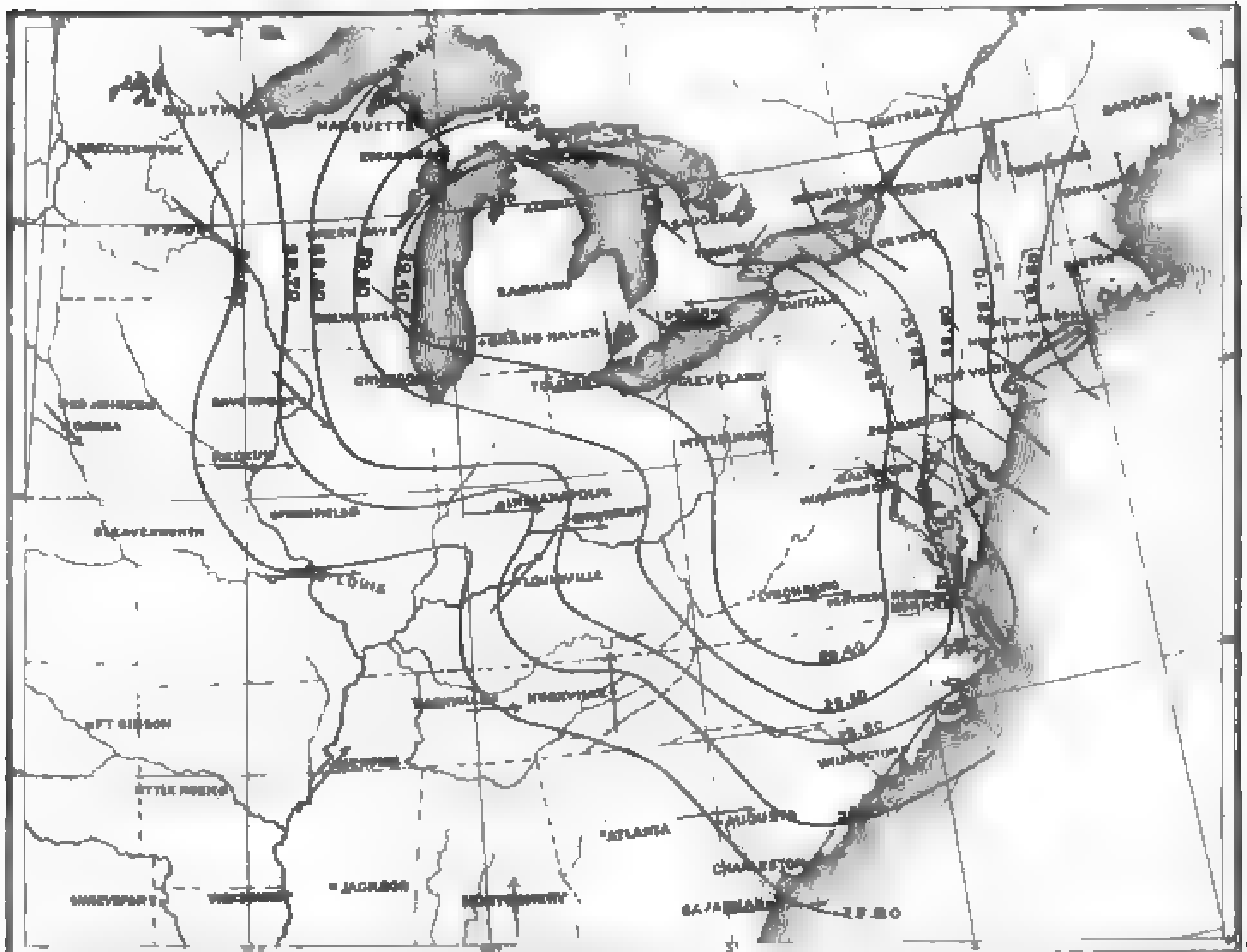
p. 488, line 8 from top, for WALTER, read WATSON.





STORM OF MARCH

PLATE



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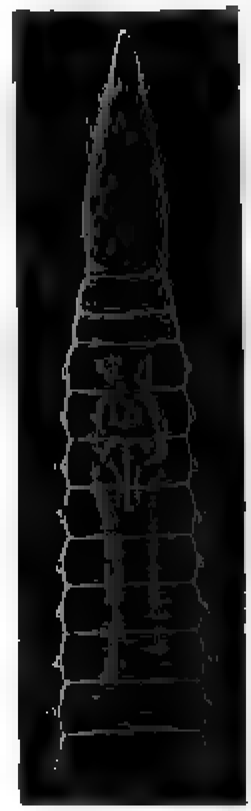

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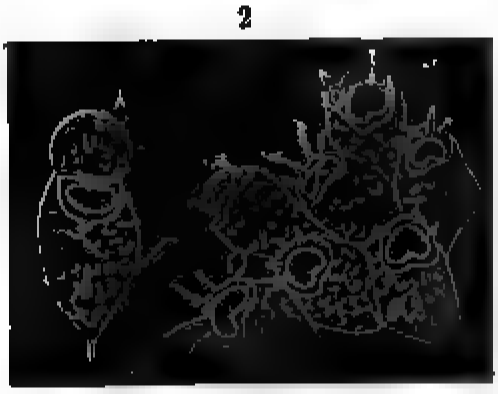

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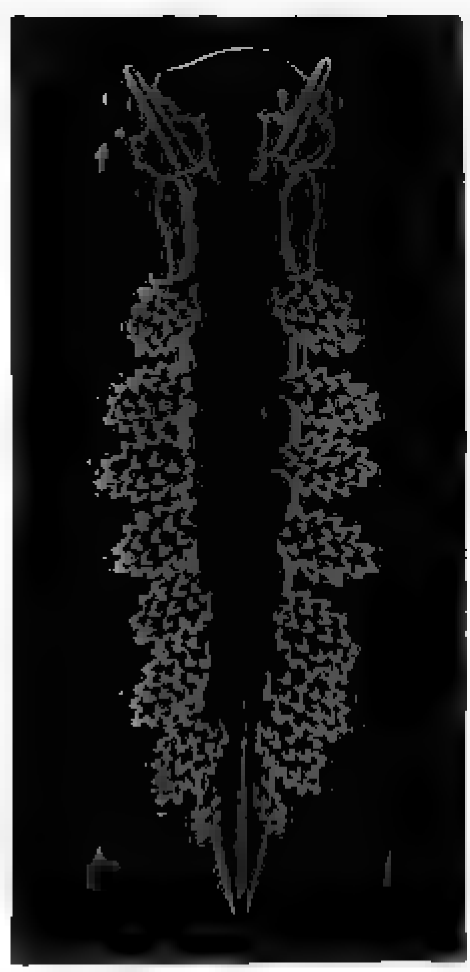

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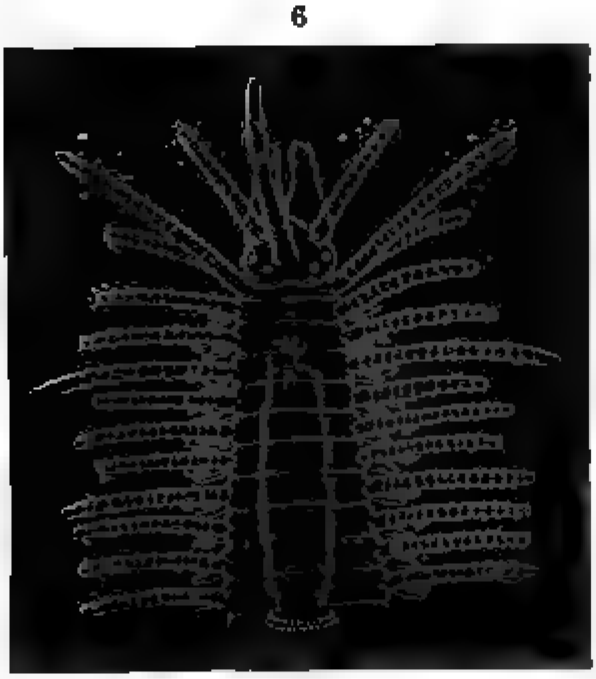

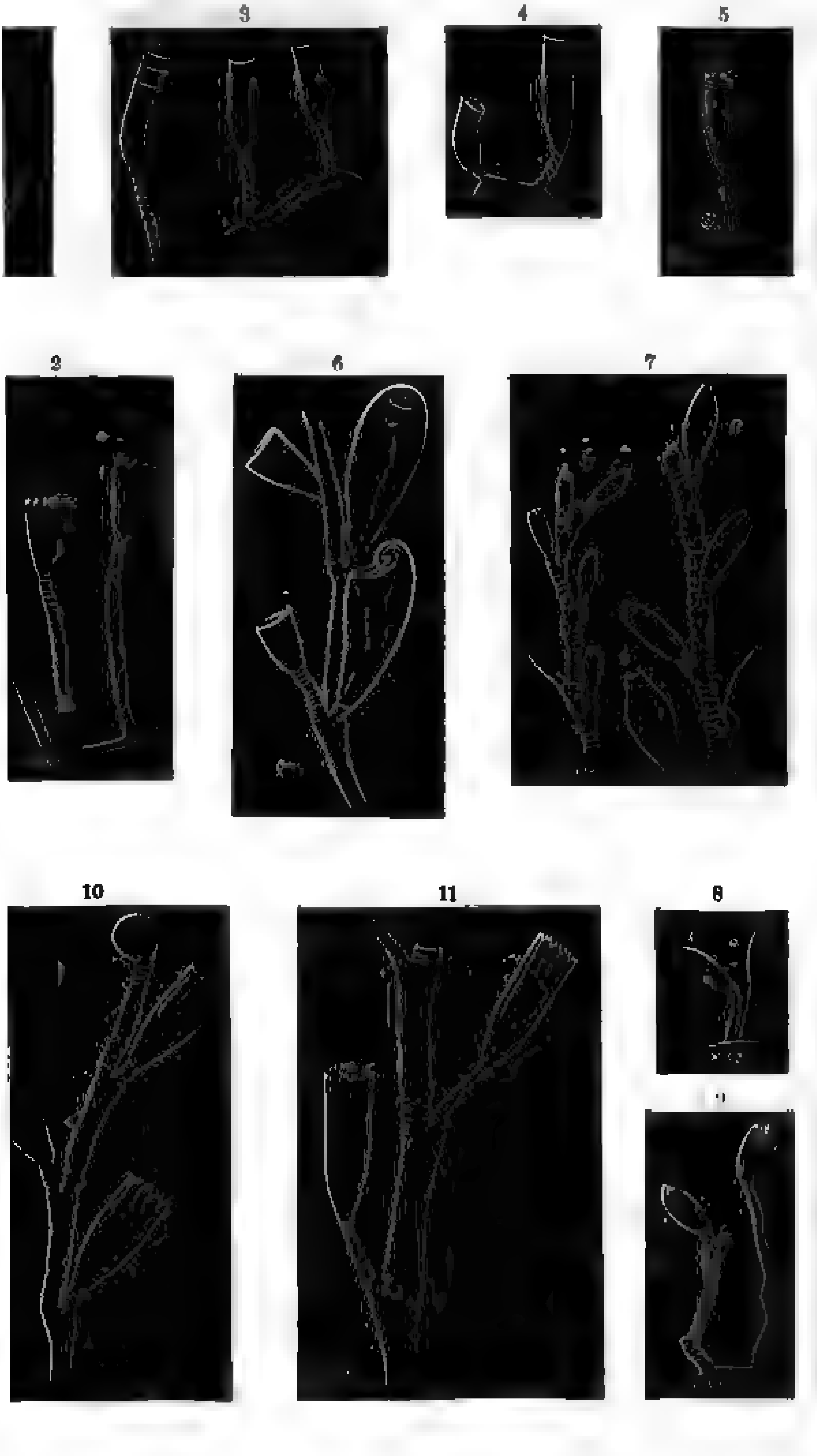
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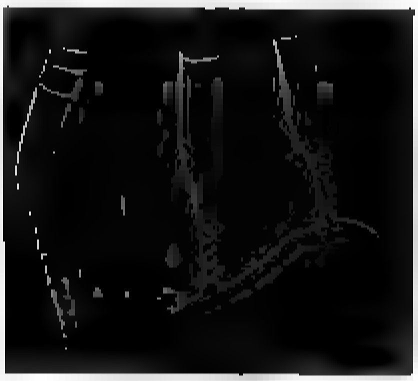

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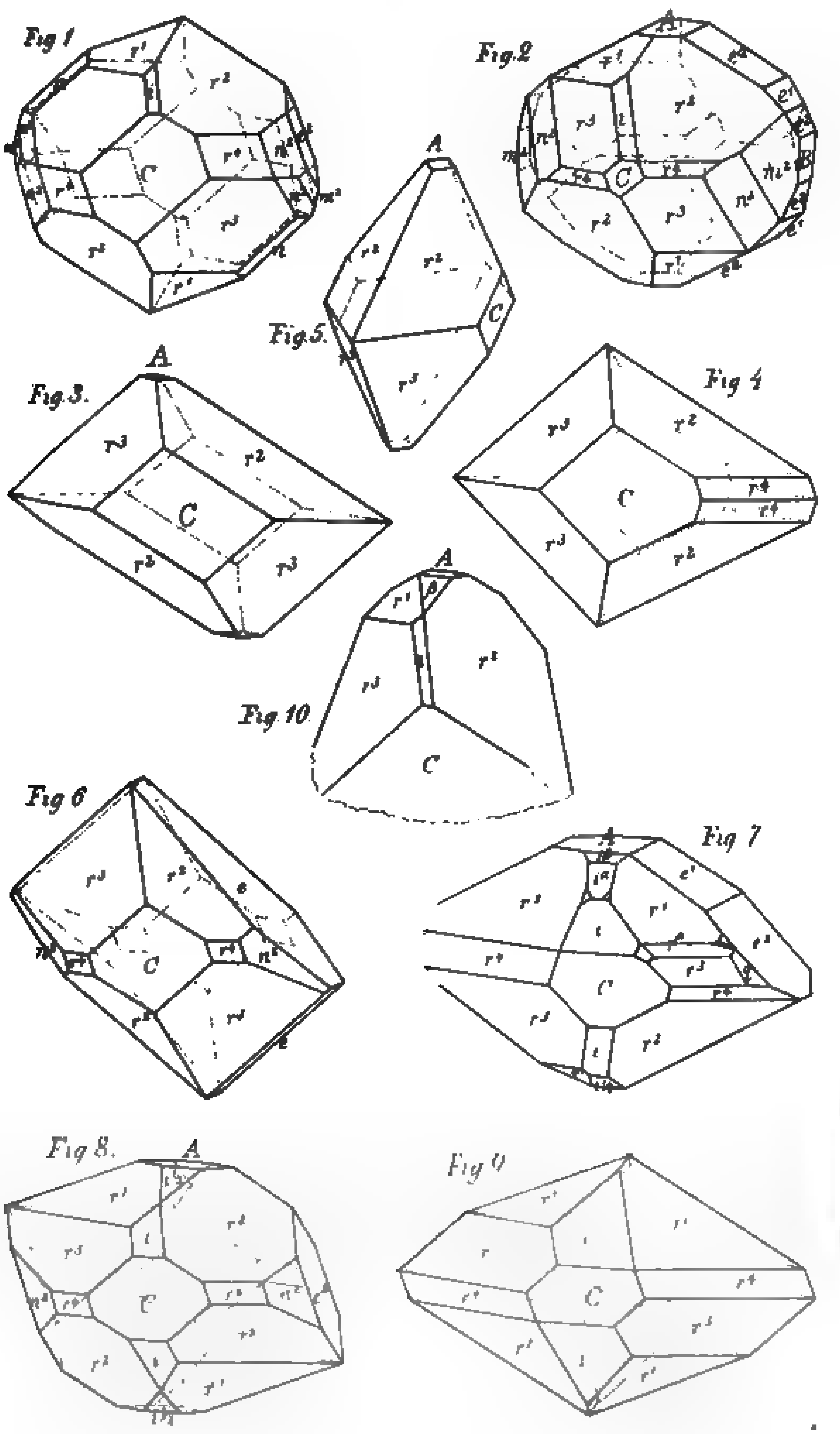
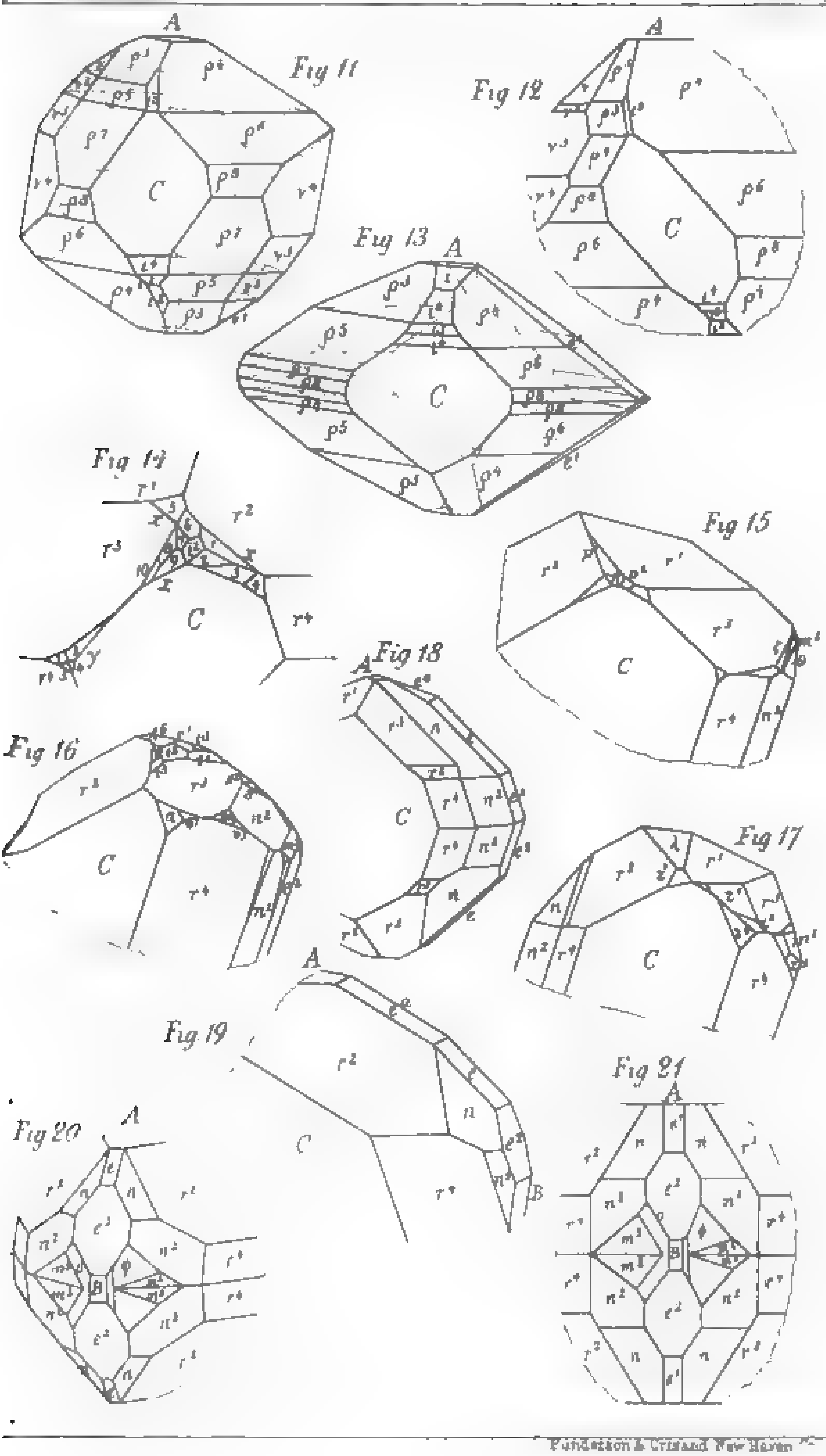
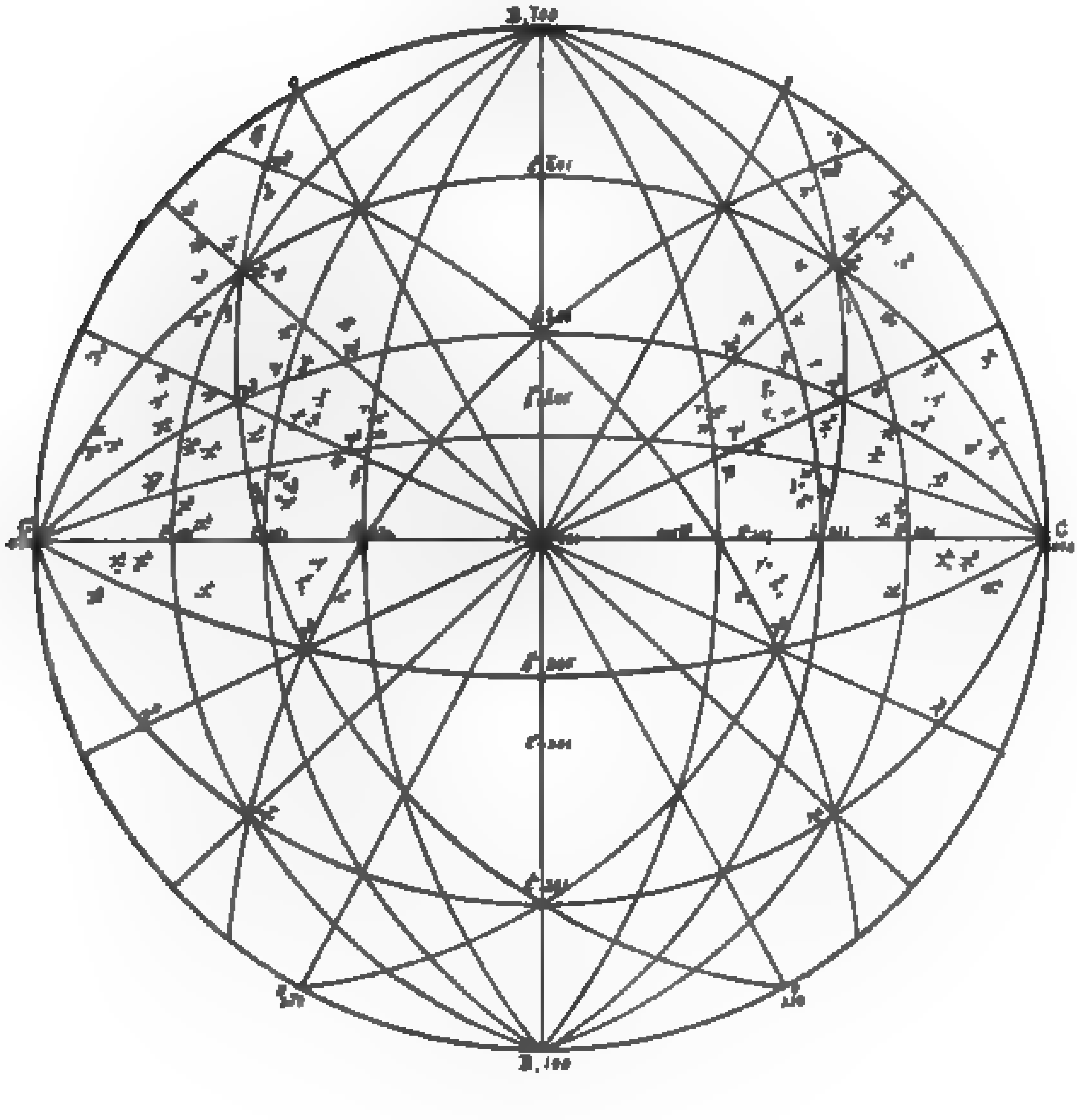


CHONDRODITE, BREWSTER, N.Y.



Punderson & Crisand New Haven

CHONDRODITE BREWSTER, N.Y.



CHONDRODITE

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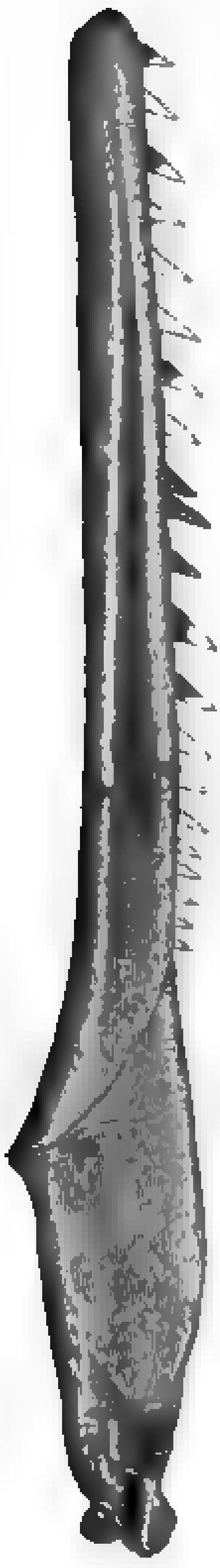

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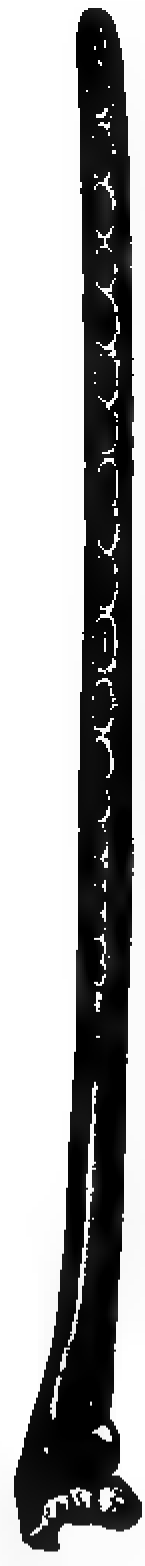

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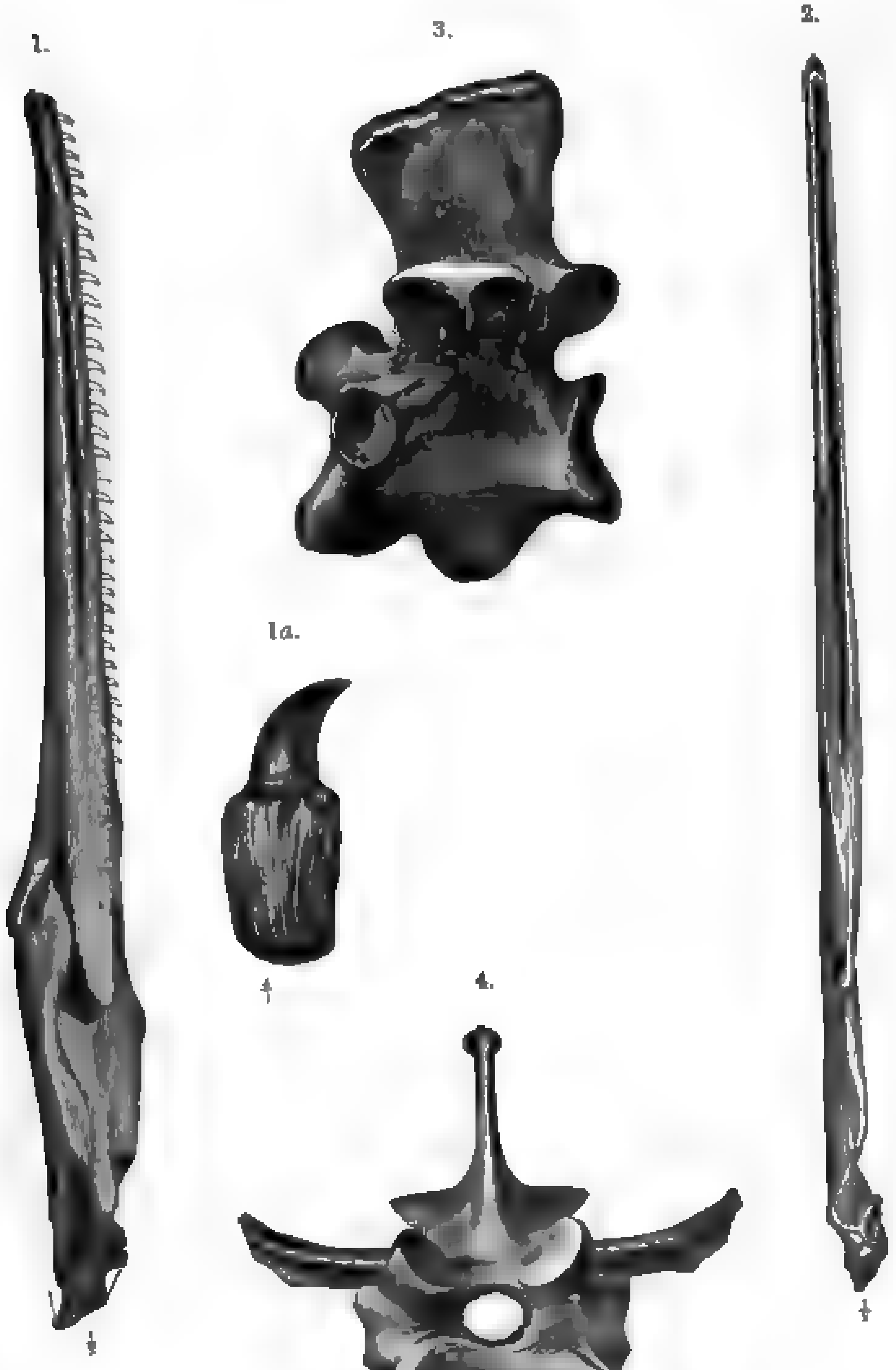
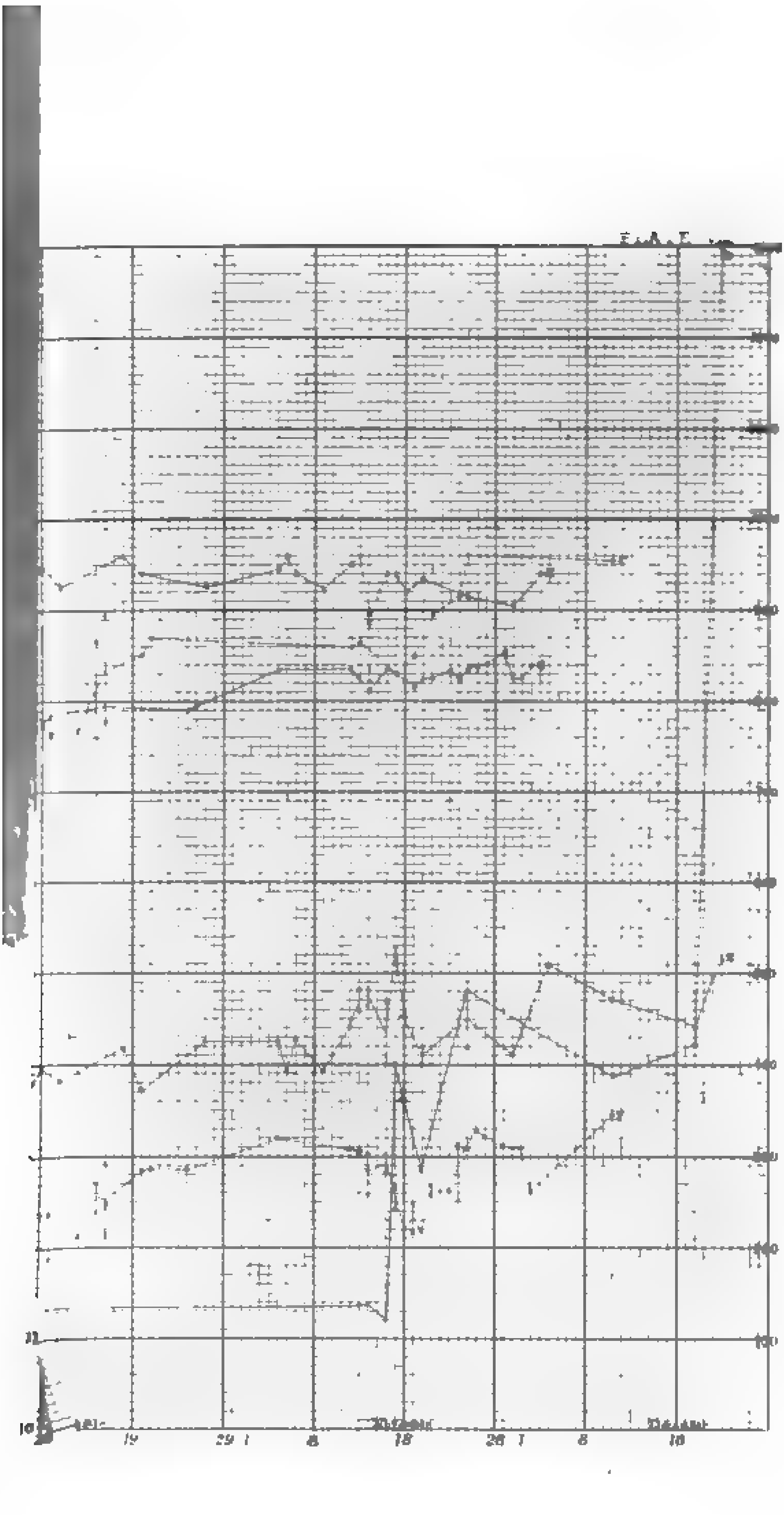
ICHTHYORNIS DISPAR Marsh. ?

Plate X.



HESPERORNIS REGALIS Marsh.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